THE

ELECTRICAL REVIEW.

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THE EIGHT HOURS DAY MOVEMENT.

THE report of the result of one year's working on the 48 hours week at the Salford Iron Works, which has just been issued by Mr. William Mather, M.P., is very pleasant reading. Those of us who have had the experience of the 10 hours day, and still remember the quarter-past five call in winter mornings, the piece of bread eaten on the way to the works, works without a fire, and the occasional indulgence of a sleep-in, can realise what a difference it must make in the aspect of a working man's life to get breakfast comfortably before beginning the labour of the day, and to have only two spells of work in the day instead of three.

Messrs. Mather & Platt are not the first firm who have made the experiment of an average eight-hours day and found it a success. Mr. William Allan, M.P., of the Scotia Engine Works, Sunderland, Messrs. Short Brothers, shipbuilders, Sunderland; Messrs. S. H. Johnson & Co., Engineering Works, Carpenter Road, Stratford, E., and some others, had previously established the 48 hours week at their works. In each case the same weekly wages have been paid for the short as for the longer hours, and notwithstanding the higher rate of wages per hour, the cost of work has not been in any instance thereby increased. What marks the experiment at the Salford Iron Works as more important is the magnitude of the works, 1,200 men, and the great variety of work carried on there, and that the experiment has been carried out with every precaution taken to ensure scientific precision in reporting the results.

Although the expression "eight-hours day" is employed in reference to the hour system under consideration, it must be remembered that, for five days, the men work $8\frac{3}{4}$ hours each day, and on the sixth day $4\frac{1}{4}$ hours. The hours are 7.45 to 12, and 1 to 5.30, stopping at 12 on Saturday.

The change effected is not the result of any theorising about the nature of human energy and its depreciation by expansive action, nor is it the outcome of a conviction about the rights of man, or any other philanthropic fad. The energy of man and the energy of steam have been employed somewhat analogously. The approved practice has been to work out what is in either, in three stages: the morning, the forenoon, the afternoon for the one and the high-pressed, the intermediate and the low-pressed for the other. The unavoidable loss in transfer between cylinders, and the rapid extinction of effective pressure, against an irreducible back pressure, makes the loss with greater expansion an increasing proportion of the more slowly increasing onward effect. The engineer is thereby admonished to consider whether the extension in volume does not go beyond that at which the opposite tendencies are equalised.

Mr. William Allan is familiar with this aspect of the steam engine, and he saw first, and Messrs. Mather & Platt saw afterwards, that their fifty-three hours triple never got

the full steam pressure for which the boiler was constructed. They said to their workmen: "Fire up, get the intended initial steam pressure, and we will do away with the third cylinder." The men responded to the call, and get in return an hour longer in bed in the morning and time for a comfortable breakfast before going out. The latent heat of steam, and the latent energy of workmen, are alike mysterious; the Second Law defines the available in the former, but only Piecework can approximate to the available in the latter. Although the time of piece-workers has been equally reduced five hours in the week, the difference in money earned by them over the trial year has been that corresponding to three-quarters of an hour only, and even this difference was being extinguished as the year advanced. In no single instance had the piecework rates been increased, in fact, in a few special cases reductions had been made.

After only a few months trial of the shorter hours, Mr. Mather felt so assured of the mutual benefits accruing to employers and employed from the change, that he felt it to be a matter of public duty to apprise the heads of the chief Government departments—the War Office, the Admiralty, and the Post Office—of the advantages that would be derived by the adoption in them of the 48 hours week. After a conference with these chiefs, only a few weeks elapsed before the Woolwich authorities heartily adopted the 48 hours week, and since then the dockyard authorities have announced their determination to do the same.

We cannot sufficiently express our admiration of the spirit in which Messrs. Mather & Platt have carried out this great improvement. The words of their appeal to the men for co-operation deserve to be engraved, as on an altar plate, in every hall where meetings of trades unionists are held, to exhibit and to perpetuate the kindly feeling which does exist in the minds of employers. "This experiment is sure to entail some considerable sacrifice upon us; but if it will enable us to make a permanent custom of the trade, that which is now only a matter of hope and desire, we shall count it a privilege to have aided you in proving that your aspirations are perfectly consistent with the maintenance of the welfare and prosperity of the engineering industry." And when the year of trial has expired, Mr. Mather says: "I attribute the full maintenance of our production through the trial year solely to the unimpared and cheerful energy on the part of every man and boy throughout the day. We seem to have been working in harmony with a natural law, instead of against it, as in the unnatural conditions of men beginning the work of the day without the provision required by nature for the proper exercise of their mental faculties and physical powers. The changed home life must also count for something. Every man can now associate with his family before leaving for the day, and the breakfast table may give him a good send-off in a cheery spirit, which he maintains in all he does."

We cordially agree with Mr. Mather in the sentiment which animates his utterances, but we hesitate to adopt his conclusions regarding "the provision required by nature for the proper exercise of their mental faculties and physical powers." There are two natures to be considered in man, his physical nature and his moral nature or disposition. To a great extent these supplement one another. It would be bad for England if the experiment at the Salford Iron Works proved that her workmen were incapable of doing more work in a nine hours day than in an eight hours day. Our workmen are not oppressed either physically or mentally by their daily occupations. What galls them is being under restraint. After the exhaustion (?) of a nine hours day, a man sitting on his own bicycle will in an hour do more work, both physically and mentally, than he did in the whole day's work before. To-day we carefully observed the appearance of workmen in a large engineering works where, under amicable relations between employer and employed, in well lighted, well ventilated workshops, the men have for years been working from six in the morning until seven at night, less the usual meal hours and Saturday afternoon. Here there is no piecework, for every man is so stimulated by bonus and personal interest in the success of the works that no other incentive can find any place for action, and each is doing his level best all the time. We could see no sign of weariness or lack of interest, only cheerful activity on every side. Have these men, then, less objection to the restraints of employment? No; but, in the tangible proofs of increased savings by present industry, they see before them a possible future when the whole of their time may be their own. Savings, in general, when they have any existence with workmen, are only a small percentage of the man's earnings. By increased industry, adding, in the case now referred to, 40 per cent. to his wages, the rate of saving is increased probably eight-fold. It is this thought that keeps the steam up to just under the blowing off pressure all the day. While, therefore, we rejoice with Messrs. Mather & Platt over the good work they have done, pulling the men together to declare their ability in an eight hours day, instead of dawdling over the same work for nine or ten hours, we claim for other men the right to do each day half as much more work, if they like, if thereby they can bring nearer to themselves the prospect of total release from servitude.

The establishment of the eight hours day as the standard, wherever it can be done without loss in production, can be only advantageous in regard to foreign competition. The character of the performance of the workmen is thereby improved, and there are then more hours to fall back upon than before, whenever it may become necessary to do so.

The proposition to legislate for an eight hours day is altogether contrary to reason. According to the experimental demonstration at the Salford Ironworks, the change from the nine hours day to the eight hours day is beneficial only. It stands to reason that it should be so. The unnecessary interruption of a meal hour is saved, and the engine power, tear and wear of machinery, lubrication, and lighting are reduced, and the men have sufficient incentive to more energetic action for the reduced time. Looking at all sides of the question, it does, indeed, seem now wonderful that when the change from the ten hours day was made, so many years should have been spent at the half-way house. Messrs. Mather & Platt also deprecate any agitation for legislation on the hours of labour for adults in healthy occupations. We must not allow ourselves to drift into the belief that shorter hours increase production. Shorter hours make better workmen, and only the best workmen can enjoy the shortest hours.

PHOTOMETRY.

Mr. Ervin S. Ferry describes, in the present number of the *Physical Review*, some experiments made upon rotating sectored discs with special reference to their use in photometry; from which it appears that, while it is physically true that the proportion of light transmitted by a rapidly rotating sectored disc, to the total incident illumination is equal to the ratio of the total aperture of the disc, to the entire disc; yet the effect of this light upon the retina will not always be in that ratio. With mixed light, containing elements of different luminosity, shining upon the retina, a rotating sectored disc will appear not to cut off all the elements in equal proportion, but will intercept most strongly the elements of low luminosity. With any given light, the error introduced by the rotating sectored disc increases as the aperture of the disc diminishes; while in the case of ordinary illuminants, the error is negligible when the total aperture of the disc is more than one-half the entire disc, but rapidly increases as this aperture is diminished.

A note is added upon the action of intermittent light upon the retina. From the study of rotating cardboard discs painted black and white in sectors, Von Helmholtz deduced the law that "if a point of the retina is excited by a light which undergoes regular and periodic variations, and which has the duration of its period sufficiently short, it produces a continuous impression, equal to that which would result if the light emitted during each period were distributed uniformly throughout the duration of the period." Plateau, Fick, and Dore have repeated the experiments of Von Helmholtz and confirmed this law; Mr. Ervin Ferry has again testified to its validity by using monochromatic light throughout a wide range of luminosity and wave length. The method employed was to compare photometrically, colour for colour, two spectra seen side by side in the eye-piece of a spectrometer; one spectrum being formed by a ray coming directly from the source of light, and the other by a ray from the same source, but made rapidly intermittent by a revolving sectored disc. The direct light of the sun, ordinary daylight, and the incandescent electric light were used as the sources. A very accurate double slit, with micrometer adjustments at the object end of the collimator, gave the means of varying the luminosity of the two spectra. Observations were taken throughout the entire spectrum, and of luminosities varying 1,000 per cent. A difference of luminosity of 2 per cent. could have been detected by this method, but no deviation from the law of Von Helmholtz was observed.

The same number of the *Physical Review* also contains a description by Knut Angström of an electrically-compensated radiation pyrometer. The principle may be briefly described as follows:—Two thin strips of metal, A and B, which are as nearly as possible identical, are arranged so that they can be exposed to a given source of heat. The faces so exposed are blackened, and the strips are set up in such a way that it is possible to determine accurately when they have the same temperature. A current of any desired strength can be sent through them. If, now, A is exposed to the source of heat, while B is protected by a screen, the balance of temperature may be restored by sending a current of proper strength through B. When the temperatures have thus been equalised, A and B are receiving energy at the same rate; and, knowing the various constants of the strips, an equation can be formed from which the thermal values may be determined in terms of the electrical energy supplied. In order to counteract the inequality of the strips, they are made interchangeable, so that B is illuminated and the current sent through A. The strips employed are of platinum; they are mounted side by side in a frame of ebonite. Several alternative methods are given, whereby the errors of observation are diminished. No definite details appear from which the sensitiveness can be judged, nor is it possible to infer the accuracy of the method from the tests described.

To Pouillet is generally ascribed the invention of the pyrheliometer, where a blackened surface is used for catching up the solar beams; and a serious objection was lately hinted at by Prof. Minchin against such instruments, namely, that there may be forms of energy which take no notice of blackened surfaces, and which refuse to be converted into heat by means of them. This is a question of the greatest interest, underlying, as it does, the truth or not of the doctrine of the dissipation of energy; and it is possible that with some such apparatus as this devised by Knut Angström, some further materials for speculation may be afforded.

Electro-magnetic Rotation.

It is believed by most physicists that much information is to be gained by comparing the values of the physical constants of different bodies, especially with a view to determining whether any connection exists between them, and, if so, what this connection or relation may be. In many of the German physical laboratories much research is in progress with regard to these matters. One of the first-fruits must be placed to the credit of D. Humburg, the object of whose investigation was to ascertain whether a connection exists between the magnetic rotation of an electrolyte and its electrolytic dissociation. As the result of many experiments made on fatty acids and on inorganic salts, Humburg concludes that the magnetic rotation is independent of the dissociation, or, to put it another way, that electrolytic dissociation has no appreciable influence on the magnetic rotation.

Electrolytes and Non-Electrolytes.

A sharp line of division has usually been drawn between electrolytes and non-electrolytes, their properties having been presumed to be widely different; and the researches of Arrhenius and his school promised to elucidate these differences in still stronger contrast. Closely related to the phenomena of dissociation are those of the lowering of the freezing point of dilute solutions by the dissolution of other substances in them. Researches on this subject by Van't Hoff and others have been described from time to time in these pages. Our notions about these matters, however, appear likely to be completely upset by some work which has been in progress for some time in Prof. Ostwald's physical laboratory. Mr. Harry Jones, there, has made a number of freezing point determinations with weak solutions for which a very high degree of accuracy is claimed and which have led him to the unexpected conclusion that non-electrolytes exhibit abnormally large depressions of a character similar to those exhibited by electrolytes. This, as Dr. S. U. Pickering points out, must necessarily invalidate all the conclusions drawn from the abnormal depressions given by the latter. But the question arises whether this high degree of accuracy of method can justly be claimed. Dr. Pickering thinks not, and he supports his contention by reference to the experiments of Raoult and Loomis; and by a comparison of Mr. Jones's values with those calculated from Kohlrausch's conductivity determinations. So we may expect a new "battle royal" to be set on foot over this side issue of the theory of dissociation.

LIVET'S PATENT REFUSE DESTROYER.

The attempt to float a company to work this patent with a capital of £600,000, the greater part of which is to go directly into the promoters' or patentee's pocket, demands even more special attention than we have hitherto devoted to it. Seeing that there is nothing in the arrangement of Livet's furnace to render it better or worse than a dozen other furnaces by an amount greater than two-pence half-penny, it is difficult to find words to describe this latest attempt on the pocket of the innocent investor, without going beyond what may be termed the ordinary limits of criticism.

Our first acquaintance with Mr. Livet dates back some 10 or 12 years, when we met him as the advocate of a system of flueing boilers as regards the external brickwork and chimneys, which was claimed to secure wonderful results by reason of the gradual increase of the cross section of the flues up to the chimney top. There was absolutely nothing in the system beyond the one good point of roominess, already recognised as a desirable feature in brickwork flues. Beyond this, Livet's system was not any better than the ordinary modern setting of the Lancashire or Cornish boiler, and far less convenient. Now we find the owners of the Livet furnace flying at higher game and endeavouring to draw money from the public by statements as to what the destructor has accomplished with refuse, which we entirely refuse to believe. If anyone will turn to page 467 of Molesworth's Pocket Book, 21st edition, they will find there a cross-sectional view of a Fairbairn five-tube boiler, which is practically identical with the cross-section of Livet's destructor boiler. The whole thing, if floated, will, we feel sure, prove a delusion and a disappointment to investors. It would pay them far better to invest a million in a scheme to make and sell Lancashire boilers, and grant the writer six hundred thousand for this advice.

Let us go into ancient history some little distance, and show how the investor was five years ago done out of nearly £200,000 for a so-called patent furnace that had at least as good a showing of probable success as this Livet system. We refer to the Hopcraft furnace. One Lewis Hopcraft, who had, we believe, dealt in firebars for some years, conceived the idea of the Hopcraft furnace. He put himself in the hands of a syndicate, whose head quarters were at 37, Walbrook. There always is a *syndicate* when the public is to be allowed to come in. Well, then, this syndicate of big and little fry—the latter, by the way, receiving cent. per cent. on the money they put into the venture, spent, we believe, £10,000 in full and half-page, and other advertisements in the daily press; they simply flooded the country with their advertisements of this furnace which had "solved the smoke problem." The affair went to subscription, and about £180,000 was subscribed. Of this, £25,000, it is said, went to Mr. Hopcraft, about £105,000 to the syndicate, and £50,000 to the company to make and sell the furnace. Now it will hardly be believed, that while this was going on, there existed an almost roofless experimental shop in or near Cable Street, Shadwell. It contained an old shearing machine. Three experimental furnaces were more or less at work; one was in a small vertical boiler in Homerton, N., at a dye-works; one was on a penny steamer on the river, and it was on this steamer that the usual burst of enthusiasm was got up, and champagne flowed in quantity enough to nearly float the steamer. It floated the scheme anyhow, and yet the test was utterly valueless, for these penny steamers require so little fire to propel them, that anything will do for a furnace.

The mainstay of the promoters was, however, a little Cornish boiler at Messrs. Causton & Sons, the stationers in Southwark. A Hopcraft furnace, with the usual fan draught, was put into this boiler, and in place of using expensive coal, cheap coal was employed, and the furnace kept the boiler at work at a cost of one-half the previous cost. It was not, however, stated that the grate area of this boiler had been very excessive, and that its duty was nearly nil, and that so far as the patent furnace reduced the grate area, it was a good thing, but the same result could have been obtained by a dozen bricks or a couple of pails of fireclay to cover the back end of the bars and reduce their area. This statement of 50 per cent. saving in cost of fuel was true; it was also utterly misleading. Tried in fully worked Lancashire boilers at Messrs. Spillers, corn millers, Cardiff, the furnace completely failed; so it did in Yorkshire and in Birmingham, in Sweden and in Germany. In fact, not a single success was made, and to our knowledge this was predicted of the furnace by an expert, from an inspection of the drawings, before a single furnace had been made by the company, and any engineer competent to judge a furnace would have given the same opinion. Yet this furnace was floated, and carried ruin and desolation into many homes. The foregoing is a brief account of how a furnace was palmed upon the investing public by means the most paltry conceivable. We are not writing to condemn the Livet destructor. It may be, probably is, a very excellent means of utilising refuse, though we have our doubts as to its capacity for taking everything in at its small furnace doors. We do, however, positively state that there are thousands of boilers equally fitted for the same work, but none of them, we venture to say, could come within measurable distance of a wide furnace fitted with Juckes's travelling grates of the sort so much used in Halifax itself at one time for under-firing Lancashire boilers. In the Juckes furnace the fire is some 5 feet in width. The grate is like a link belt, built up of iron bars and pins; the whole furnace is removable, being on a wheeled frame, and the heat generated is so intense that the brick arch over the dead plate was usually run to slag. With refuse, such an intense heat could, of course, not be secured, but the best possible results could thus be got from refuse; and, personally, we would sooner pay double or four-fold for a Juckes than for a Livet furnace. The mischief is, however, in the price asked. Let the promoters reduce their claim to £600, or, better still, to £60, and we should not feel called on to make any objection, as there may be small towns where, coal being cheap and Mary Ann careless, the Livet furnace could be employed.

To pay only 5 per cent. on a capital of £600,000 means a profit of £30,000 annually. It means fitting up ten furnaces every week at a net profit of £60 each, and it means doing this in the face of all the boiler makers in the country, who could, without a penny of royalty cost, supply an equally good boiler for the purpose for less money. A dozen years ago we visited the yard of the Manchester Corporation in Water Street, and there found refuse was being burned in ordinary Lancashire boilers. There is no serious difficulty in the matter. If the refuse is very wet—indeed, in any case, we should prefer to see it burned in a firebrick chamber, whence, after combustion was complete, the resultant gases should pass to the boiler. Wet refuse cannot be inodorously burned in a heat absorbing furnace, and it is the common error of many to be in too great a hurry to drag the heat out of the products of combustion as soon as generated—to distil the wet refuse into malodorous vapour in place of first burning it, and then endeavouring to save the heat generated. But it really is too bad that the public should be asked to pay for such ill-considered unscientific schemes, which carry on their face their own condemnation, and are apparently known by their promoters sufficiently well to make these wary gentlemen fight shy of genuine tests. If the owners of the Livet furnace had a good thing to sell, they should surely not hesitate to have had made a most searching test by reliable men.

The promoters of this scheme, now that hostile criticism has been aroused, are offering to wager a small sum that their statements are correct—throwing a veritable sprat of £200 to catch a £600,000 whale. Then they express themselves, in a letter to the *Pall Mall Gazette*, as desirous of paying the expenses of a commission of experts, naming their experts, who are by no means, as a body, such a set as a practical engineer would choose for such a piece of work. All this is so much *blague* for the purpose of encouraging the investor to go on trusting in promoters so wishful for expert tests. The promoters know only too well that long before the fruition of their offers the scheme will have been subscribed for, if it is to be, unfortunately, floated, and the poor investor will be hopelessly in the vortex before he learns the opinion of the experts, who ought to have been called in before issuing the prospectus. We shall not in a hurry forget the Church clergyman who came to us for advice as to the Hopcraft Company. The poor man had invested £800—his life's

savings—in the company, and had held on until the value of his holding was but £100. We repeat, bad as was the Hopcraft furnace, it had elements in its design that rendered it a better investment than the Livet patent. Finally, we would warn investors that they will find it difficult to reach any responsible person when the money is found to be lost. In all these affairs the inventor sells to a syndicate; the public cannot touch the inventor. The syndicate unloads upon the public, and at once goes into voluntary liquidation; and a syndicate thus dissolved has no *point d'appui*—no soul to be damned, no body to be kicked. There are the directors, it is true. Of these, the wealthy ones come in after allotment—they bear no share of original sin. First directors are frequently mere guinea-pigs, and not worth powder and shot. Directors, moreover, shelter themselves behind the engineering expert whose report figures in the prospectus. He was a man "in whose opinion they had every confidence." Should the Livet scheme go forward, Mr. Perry F. Nursey will be surprised to find how, in earning his few guineas, he has secured the good opinion—when the row comes—of the Livet directorate; how they will shelter themselves behind a Past-President. In nine cases out of ten, such is the weakness of the average fee-hunting director, no personal investigation is made of a patent or invention even by directors whose profession as engineers should qualify them for this, and the men are few who will refuse a directorate until they have personally, or by reliable deputy, made an investigation. The names of the directors are absolutely no guarantee of the genuineness of an invention to be foisted on the public, nor do the shares standing as fully paid up in their names represent any out-of-pocket expenses on the part of the directors. These directors' shares usually imply that the promoters have disgorged swag to the amount necessary to fit up the board with a presentable holding. *Verbum sap.*

We had almost forgotten the biggest piece of impudence in the whole affair of the Livet patents, to wit, the payment of the huge sum does not even purchase the "patents" outright. It purchases the right to use them in London and 20 miles round, subject to a heavy royalty per ton of refuse burned. Could impudence go further than this? In other words, the sum asked from the public for the right to burn refuse amounts to one pound sterling for every two houses on the basis of an average of five persons per house, or 2s. for every man, woman and child in the area, taking the population as six millions. It seems almost incredible. Last year was, it is true, an exceptional year, but other years may well be the same. Now, last year, the writer's household of six consumed three tons of coal. Can it seriously be contended that the refuse from this miserable three tons is worth 12s. for the right to burn it. The coal itself only cost 57s., and yet the public are to pay 12s. for the right of burning the refuse, and something more for the trouble of doing so when mixed with damp vegetable matter and bones, or an occasional neighbour's cat.

The idea is so preposterous, that it seems almost supererogatory to deal with it; nor would we do so were it not that such schemes are put forward in a manner, and with a backing, that deceives the unwary.

ELECTRICITY IN PIPE LAYING.

We are indebted to the *Bulletin de L'Industrie Française* for a description of a novel method of pipe laying, which, as it involves the use of an electric locomotive, will be of interest to our readers. This new method has risen out of the unusual weight of the pipes required in the Paris water supply works, the pipes being lodged in culverts, and of 1·50 m. diameter. The pipes, ranged above the culvert along the footway, were carried to the manholes on bogeys, and dropped into the culvert by windlasses of 2,000 kilos. capacity carried on a derrick or frame. In the culvert the pipes were transported by a carriage termed a porter, built up of a pair of girders fastened to an iron circle, the whole being of wrought-iron plates and angles carried on four rubber-tyred wheels rolling on cemented banks in the gallery. Four horizontal guide wheels preserve the alignment of the porter. The transport of the pipes within the gallery was effected throughout the greater part of the work by means of an electric locomotive harnessed to the porter, and, like it, rolling on the floor of the gallery. The locomotive was a simple affair built up of a timber frame, with an axle at each end and lateral guide rollers at the angles of the frame. Motion was imparted to the axles by a motor of three horse-power, placed at the middle of the frame, through intermediate gearing, and a pair of pulleys with crossed and open belts respectively, for forward or backward running.

Current was produced by 40 secondary cells placed in the space not occupied by the machinery. These cells furnished also the necessary light. They were recharged every night by means of a portable engine and dynamo installed at the surface near the manholes. There is also described an arrangement for centreing each fresh length of pipe, as it was brought to position, and making the joint, which, however, we need not further dwell upon. The salient feature is the successful use of an accumulator-driven locomotive in a novel piece of work, to which a steam propelled locomotive would not have been applicable without special means of ventilation, and then only at great inconvenience.

MAGNETIC QUALITIES OF IRON.

By ROLLO APPLEYARD.

The *Phil. Trans. R.S.*, Vol. 184, which has lately come to hand, contains the important researches of Prof. Ewing and Miss Helen G. Klaassen with regard to the "Magnetic Qualities of Iron." The extended use of transformers has called for concise data upon the cyclic magnetising processes in iron. It has become a matter of consequence to investigate, in various specimens of metal, not only the amount of the energy dissipated in hysteresis in a magnetic cycle, but the relative amounts under various degrees of magnetisation, and various intensities of magnetising force. Other questions arise with reference to the dependence of this loss upon the frequency of the cyclic process, and on the manner in which it is performed. The experiments described in the paper deal mainly with the effects of cyclic variations of magnetising force. They are intended to contribute some additions to existing data, to answer one or two specific questions, and to exemplify certain, more or less, novel methods of experimental enquiry. A section at the end of the paper relates to the molecular theory of magnetisation, and its adequacy to explain some characteristic manifestations of hysteresis.

The device used throughout all these experiments implies only one current and one magnetising coil, yet it retains the advantage that each point of the cycle is reached by a single step from the end of the cycle. The novelty of the method is that, by a single movement of a key, the magnetising current is at once reduced in amount and reversed in sign; thus a motion of the key in one direction determines a new point on the curve, while each movement in the opposite direction brings back the magnetisation to its extreme value. In this way as many points are found as may be required to define that part of the curve which lies between the zero of magnetising force and its extreme negative value. To find points lying between the positive extreme and the zero of magnetising force, a different process is adopted. The key is kept over, say to the left, and a sudden reduction of the current—without change of sign—is effected by inserting resistance. This resistance is, however, automatically cut out when the key is again tilted over to the right, so that, in the latter position, the maximum current is always restored. By selecting successive values for the added resistances, the points are found corresponding to the first quadrant of the descending curve, the magnetisation of the sample being restored to its initial full value before each such step.

All the samples tested in this set of experiments were arranged in the form of rings; the magnetising coils being uniformly wound upon the whole ring in a single layer, or two layers. The ballistic galvanometer method was employed for determining the magnetisation. A few turns of wire, wound outside the magnetising coils, formed the secondary or induction coils.

A curious, but, it appears, quite general, feature in the relation of the cycles to one another is shown by the curves obtained by this process: The extremity of each cycle lies outside of the rising curve of the immediately higher cycle, provided there is no very great difference in their ranges of magnetisation. It is only when coming down to the lowest cycles, where the steps by which B is reduced from cycle to cycle are relatively great, that this does not happen. It should be remembered that each of these cycles is taken only after a large number of reversals of that particular magnetising force which determines its range. From these curves, by measuring the enclosed areas, values have been found for the energy dissipated in performing the cycle, namely, $\int H\,dI$, or, $\frac{1}{4\pi}\int H\,dB$. The amount of demagnetising force just sufficient to bring the magnetism to zero, or, as Hopkinson calls it, the *coercive* force, is seen from these tests to rise progressively as the magnetisation is augmented; its measured values are given by the experimenters in the form of tables. By extrapolation of the curve representing these results, an estimate is made of a definite physical constant of the material, forming a criterion of its magnetic hardness, namely, the coercive force which would correspond to the state of magnetic saturation. This, in other words, is the demagnetising force which would be just sufficient to remove magnetism from a sample which had been magnetised to literal saturation. The saturation value of I, in wrought iron and steel, is known to be about 1,700. A conjectural extension of the curves along the straight lines which they follow in the region of strong magnetisation shows that the coercive force of saturation is probably about 5·5 in rather hard iron, and something like 8·5 for steel.

It is interesting to follow the tests on bright iron wire. On winding it into a ring, without, in the first instance, taking any steps to secure insulation between neighbouring turns of the wire, the Foucault currents in the ring were so influential as to make the tests, in this condition, valueless—in all the previous examples the wire or sheet metal forming the core had been insulated by cotton or paper. The ring was then soaked in a hot bath of boiled linseed oil, which was allowed to penetrate freely to the core; this is a treatment similar to that actually followed in the treatment of transformers, and it was effective in preventing the Foucault currents between the turns. The experimenters suggest a doubt as to whether all that is possible has yet been done by manufacturers of iron to produce a quality specially suited for such uses as the construction of transformer cores. The conditions of manufacture which secure low hysteresis are imperfectly known, and are less generally recognised than electricians might wish.

The experiments on the heating effects of the reversals of magnetism are specially worth notice. The method consists in securing a thermal balance between two equal rings, and was devised to give an answer to the question whether, when a transformer is in action, the heating of the core, through magnetic hysteresis, is the same when the transformer is "loaded" as when it is not. In other words, whether the taking of current from the secondary coil has any influence on the amount of heat generated in the core, the limits of magnetisation and the frequency of reversal being unaltered. The conclusion is entirely to negative the idea.

Prof. Ewing's curve tracer for magnetic cycles has already been described in the Electrical Review; it has done excellent service in indicating the conditions of magnetic change at various rates of reversal. At high speeds of reversal the curve which shows the relation between the externally applied magnetic force to B is swelled out and encloses a larger area, corresponding to the greater amount of work then done, whether in generating Foucault currents or overcoming other possible sources of quasi-viscous resistance.

The latter part of the paper has reference to the molecular theory of magnetic induction, in continuation of a former treatment of it (*Roy. Soc. Proc.*, Vol. 48, p. 342). It was there shown that if Weber's view is adopted, namely, that the molecules of a magnetisable metal possess magnetic polarity, the phenomena of hysteresis, and other prominent characteristics of the magnetising process, follow as consequences of the control which the molecular magnets exert on one another by their polar forces. Thus, in the application of magnetic force to an unmagnetised piece, the molecular magnets are at first deflected stably, and in this stage there is no hysteresis. But when the force is sufficiently increased certain molecules are deflected so as to become unstable, and a breaking up and re-arrangement of molecular groups supervenes. Finally, after this process has occurred throughout the piece, a third stage is entered upon, when further stable deflections through a small range bring about the completely "saturated" state. Hysteresis is found whenever any of the molecules pass from any one stable configuration to another through a phase of instability, and this transition, being mechanically irreversible, involves a dissipation of energy. This conception of molecular structure gives an explanation of very many known facts regarding the magnetic quality of iron and steel; and some of these are capable of effective illustration by means of a model, consisting of small magnets pivoted like compass needles, on fixed centres, and placed sufficiently near to one another to allow their mutual polar forces to be strongly felt. In elucidation of this theory the experimenters have made a number of observations with such a model, and have succeeded in demonstrating the various phenomena of hysteresis and saturation, in a manner which is scarcely to be excelled. In these operations the behaviour of the model agrees in all respects with that of a magnetic metal. The same close correspondence is found, even in less obvious features of the magnetising process. When a piece of previously magnetised iron or steel is acted upon by a magnetic force sufficiently strong to carry the metal to the high stage of permeability, but not strong enough to make it approach saturation, and this force is then caused to vary between equal positive and negative values, it is found that the first application induces more magnetism than is induced by subsequent applications, and that the changes of magnetism do not become cyclic until the force has been several times reversed; and, during this gradual approach to a cyclic *régime*, the range through which the magnetism varies between its positive and negative extremes becomes reduced. The same phenomena occur in the model, provided the little magnets have been previously shaken up and allowed to settle in the absence of any directing field—a condition which may be supposed to correspond to the annealing of the solid metal.

THE BEHAVIOUR OF GASES UNDER THE INFLUENCE OF ELECTRICAL DISCHARGE.

When an electric discharge is passed through a gas the properties of the gas in the neighbourhood of the line of discharge are modified. Hittorf and Schuster have demonstrated that the gas along this line of discharge is no longer an insulator, properly speaking, but can transmit a current under a very small potential difference, and Faraday's observation that when once a spark has passed through a gas, a "path" is formed, which appears to facilitate the passage of another spark, is another illustration of the same order. This would seem to point to the formation of a modification of the gas possessing a much greater electrical conductivity, and Prof. J. J. Thomson has shown (*vide Phil. Mag.*, November, 1891) that the conductivity of this modified gas is comparable to that of strong solutions of electrolytes.

The subject has recently been approached from an entirely different point of view by Mr. E. C. C. Baly, who has contributed a paper embodying his researches to the *Proceedings* of the Physical Society. He examined the separation and striation of rarefied gases under the influence of the electrical discharge, and discovered that in mixtures of gases, *e.g.*, hydrogen with carbon dioxide, carbon monoxide, nitrogen, sulphur dioxide, iodine vapour and mercury vapour, one of

the gases (in these cases the hydrogen) separated from the other and became collected about the negative pole, especially in the region of the "glow."

This separation does not appear to depend upon the relative molecular weights of the respective gases; but the process seems to be similar to that of electrolysis, one of the gases being separated out from the mixture and collected about the negative pole, whilst the other gas remains distributed throughout the tube in which the discharge takes place.

The formation of luminous striæ marks the commencement of the separation, and when the conditions were so arranged that no striæ could be formed no separation resulted; this was effected by the employment of minute electrode points.

With pure vapours and gases, *e.g.*, pure mercury vapour, no striations occurred in the passage of the discharge in whatever way the electrodes were modified. This was proved by a series of experiments with the pure vapours of iodine, sulphur, arsenic and mercuric iodide, which are not monatomic, and in which the absence of separation, as shown by the non-formation of striæ, could not be thus accounted for.

Mr. Crookes, in the discussion which followed, called attention to his own researches, which have shown that the stratification seen when a high-pressure current is passed through a rarefied gas are due to the gas not being homogeneous (*vide* address delivered before the Institution of Electrical Engineers, January 15th, 1891).

At the Royal Society on March 9th, Prof. J. J. Thomson read a paper on the electrolysis of steam, the conclusions stated in which may be considered in this connection. He showed that a modified gas is produced by the passage of the electrical discharge through steam, which consists of a mixture of oxygen and hydrogen, these gases being in the same condition as when the arc discharge passes through hydrogen and oxygen respectively, the hydrogen behaving as if it had a negative charge, the oxygen as if it had a positive charge; hence separation takes place, the oxygen going to the negative and the hydrogen to the positive electrode when the arc is used. When, however, long sparks are passed through steam, since the molecules of steam consist of two positively charged hydrogen atoms and one negatively charged oxygen, the molecule splits up in the electric field, the hydrogen going towards the negative, whilst the oxygen collects at the positive electrode as in ordinary electrolysis.

THE ELECTRIFICATION OF GASES AND LIQUIDS.

By J. E. TAYLOR.

Since Prof. Schuster delivered his memorable address on the "Passage of Electricity through Gases," it has been well known that, under the influence of the electric discharge, all gases possess a certain amount of conductivity, even for very low E.M.Fs. This conductivity is due to the production of dissociated atoms by the discharge. With gases at the normal pressure there are probably comparatively few such dissociated atoms produced, or, at any rate, they quickly unite again and the gas resumes its usual properties and is a non-conductor. In rarefied gases, however, the resumption of the insulating power is a comparatively slow process, and we find successive discharges in vacua spreading themselves over the electrodes in the well-known manner peculiar to such discharges. This spreading, of course, results from the tendency of the discharge to follow the laws of conduction and divide itself up in the various paths in inverse proportion to the resistances, rather than merely break through the part of least dielectric strength which is the case as the gas becomes denser. This property of rarefied gases to conduct under the influence of a discharge has recently been made use of by Mr. E. C. Rimington to sensitise them, so that a feeble electrostatic field may make itself visible in exciting luminosity in a bulb or tube, by simply producing an extra discharge by the application of a much more powerful electrostatic strain.

The most familiar case of conduction in air under normal pressure, is that of the electric arc which exhibits the same tendency to follow the laws of conduction by spreading over the electrodes as does the vacuum discharge, but is much more limited in extent. Dissociated atoms, and, therefore, conductivity, exist in all flames and wherever combustion takes place. Particularly is this the case in the white part of an ordinary coal gas flame which very plainly shows conductivity for low E.M.Fs. It might be supposed that such conductivity was due to a host of little conducting particles of carbon, &c., passing rapidly between the electrodes, each carrying its charge; but the amount of conductivity shown across an inch or so of flame, and the fact that the electrodes have to be very hot before it is shown at all perceptibly, do not tend to confirm this view of the matter but support the idea that the gas itself is conducting, due to the presence of a large number of dissociated atoms. The presence of these dissociated atoms has been made to account for the discharging effect on neighbouring electrified conductors, of flames and heated bodies by Prof. Worthington; but although this probably accounts for the completeness of the discharge, yet, without any dissociated atoms, such discharges would, to a great extent, still take place from quite another cause. Anything which will shift the ends of the lines of electrostatic induction or strain from a conducting solid body into the surrounding (liquid or gaseous) dielectric will effect the neutralisation of that strain, and therefore the discharge of a neighbouring electrified body. Once the end of a line of strain is in a gas it means that the gas is electrified, and because, under all ordinary circumstances, a gas cannot remain long electrified, but will move in obedience to the strain, it follows that the body at the other end of the line will not long remain electrified. Now, a sharp conducting point is a means of shifting the ends of lines of strain into the body of the surrounding gas or liquid, whether it exists on the electrified body itself or on a neighbouring conductor. It effects this through the great density of the lines of strain at the point producing so great a strain in the dielectric there, that the latter gives way or breaks down for a certain distance outwards from the point, thus landing the terminations of the lines in the body of the gaseous dielectric, which thereupon promptly responds to the attractive force put upon it by the strain, and causes by its motion the well known wind from an electrified point. A flame or hot body acts in a somewhat similar manner, only instead of the density of the strain producing a breakdown of the gas, the heat so weakens the dielectric strength of the gas that a comparatively feeble strain breaks it down and thus lands the terminations of lines of strain in the substance of the dielectric. This weakening of the dielectric strength is noticeable by the great length of spark which can be obtained over a flame; thus if a Leyden jar, which, when charged from a certain machine will give, say, a spark half an inch long in air under the ordinary circumstances when discharged, will if its outside coating be connected to a gas bracket give, perhaps, 8 or 9 inches when its knob is quickly brought over or near the flame. The discharge of electrification by flames is, however, no doubt to a great extent, if not principally, due to the conductivity of the gas as aforestated. Such conductivity is another means of landing the terminations of the lines of strain into the dielectric, for those portions of the lines which at first temporarily exist in the conducting gas die out, each leaving a corresponding end in the non-conducting exterior gas which is thereby electrified. In virtue, of course, of its insulating properties, a gas cannot become electrified merely by contact with a charged body.

It is an interesting question whether lines of strain existing wholly in, say, a gaseous dielectric (that is both terminations end in the body of the gas) could not by suitable currents or winds in that gas be caused to exist for more than a temporary period, and if so, whether they could not also be elongated, multiplied, and otherwise manipulated, so as to indefinitely increase the strain as in other forms of influence machines* If such a machine with gaseous carriers were capable of construction, which is not at all unlikely, it would

* Electrical Review, Vol. xxxi., p. 427.

not be subject to that bane of the influence machine, viz., leakage in the interior of the machine, either as brush and glow discharges or surface leakages, for there being no conducting carriers, the lines of strain would not accumulate about unavoidable projections and corners, but distribute themselves evenly in the dielectric.

It is highly probable that Nature has anticipated man in this respect, and that the terrific discharge, constituting a flash of lightning, is the effect of a gigantic influence machine based on this principle. Suppose, for instance, that air in conjunction with vegetation has a contact difference of potential, and that such difference having been established, the air is forced to rise upwards away from the vegetation and earth. In doing so, it will leave behind it, as far as it goes, a line of strain, and will thus greatly augment the difference of potentials. This may be followed by more air, which has through its conjunction with vegetation also established a difference of potentials. Thus each particle of air which has touched the earth, leaves behind it its line of strain; and if such a current of air be continued for some time without allowing the previously electrified air to return, a strong electrostatic field may be built up, and when clouds form and collect the upper ends of the lines of strain, we have the phenomenon of a thunderstorm. Such a theory of thunderstorms, incomplete as it may be, may yet possess the elements of truth in it.

It should have been mentioned in connection with the discharging effect of flames, that unlike points they will act at large distances from the electrified body. Thus it has been found by experiment that a gas jet in a room where an influence machine was worked, though at some distance from the machine, caused, when lighted, a diminution in the number of discharges which took place in a given time. But for the great amount of leakage which takes place from other causes, the discharging effect of the gas jet would, no doubt, have been much more marked than was the case.

CATHODIC RAYS IN GASES.

The rays exciting phosphoresence, proceeding from the cathode of a Giessler tube, permeate thin leaves of metal as Hertz has shown. If it were practicable to find a metallic leaflet of such a thickness, that with perceptible permeability it still closes air-tight, and is capable of bearing the pressure of the atmosphere on one side only, it would be sufficient to close an opening in the side of a discharge tube with such a plate, in order to allow those rays a passage into the air.

This line of thought has been carried into experimental effect by Dr. Philipp Lenard, of Bonn, who, in a paper read before the Royal Prussian Academy of Science, at Berlin, on January 12th, 1893, describes the method and details of his investigation. He succeeded in demonstrating that the cathodic rays, when once produced, propagate themselves into space filled with air; thus their observation is greatly facilitated, and it becomes possible to select and to vary the conditions of observation, independently of those of their origin.

The metallic leaf selected for experiment was of aluminium, 0·003 mm. in thickness. This was found to be permeable for cathodic rays, but quite impermeable to air and light. The cathode was an aluminium disc, 12 mm. in diameter, and the anode had a very large surface. The arrangement of the apparatus was such that the space for observation was kept perfectly free from light and from the electric action of the discharge. The most favourable exhaustion in the discharging tube was reached when the potential difference between its electrodes corresponded to a striking distance of 3 cm. between balls in air.

The observations made are given at considerable length, but the more important of them may be briefly described as follows:—

Cathodic Rays in the open Air.

1. The rays render the air faintly luminous with bluish light, and there is a strong odour of ozone.

2. Substances capable of phosphorescence glow when held in the rays; the intensity of the glow depends upon the distance at which they are situated from the source of the rays. The phenomena cease if a magnet be applied to the discharge tube so as to repel the rays.

3. A quartz plate interposed causes the extinction of the light. Gold, copper, aluminium foil, silk, paper, and soap bubbles scarcely weaken it. The permeability depends upon the thickness of the stratum employed.

4. The air is a dull medium for cathodic rays; these spread in a diffused manner, not rectilinearly.

Cathodic Rays in a Vacuum.

1. The more complete the vacuum the greater the distances at which the phenomena of phosphorescence become visible; the rays become brighter and more sharply defined. Conceding that the imperceptible traces of matter left in extreme vacua exercise no perceptible effect, it follows that the cathodic rays are processes in the ether.

Cathodic Rays in various Gases.

1. The gases are turbid media for the cathodic rays, and the turbidity varies according to the nature of the gas. Greater permeability is connected with greater clearness. Experiments with coal gas, hydrogen, oxygen, and carbonic acid gas demonstrate this fully. The behaviour even of the elementary gases is that of a non-homogeneous medium, each molecule appearing to exercise the function of a distinct obstacle. Arguing from the observations made, and from the theory that the number of molecules upon which the cathode rays impinge in equal volumes of different gases is always the same, Dr. Lenard concludes that hydrogen molecules "obscure" the ether to a less degree than the molecules of oxygen, and that these again obscure it to a less extent than do the molecules of carbonic acid gas.

SIR HENRY MANCE'S BATTERY RESISTANCE TEST IN ITS APPLICATION TO DUPLEX TELEGRAPHY.

[A communication.]

There are certain facts in the theory of duplex working which do not seem to be correctly understood—at any rate, by some professors of the art. We intend to treat only one point suggested by the title of this communication, *i.e.*, that the received signals at station X are unaffected in magnitude by the action of the sending key at the same station X, when duplex balance has been established.

Fig. 1 shows the diagram of duplex working on the bridge

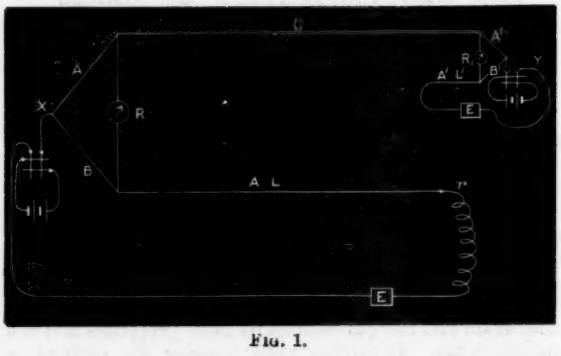


Fig. 1.

system in its simplest form. Station X is the end we shall consider, and therefore the receiving and sending arrangements at station Y are advisedly shown *en petit*, because on a long cable the whole of the arrangements at that end of condensers, resistances, &c., are reproduced on the artificial cable at station X by a single resistance, *r*, between the end of the artificial cable and earth. It may here be incidentally remarked that this is one of the simplicities introduced in duplexing a long cable, as compared with a short one, viz., that any alterations in the conditions at the distant end, Y, do not affect the working balance at the home end, X, whereas in a short cable or land line they do. It is

better, however, to word this remark somewhat differently, as it is not a case of long or short cables *per se*, but actually of the speed at which they are worked, as compared with the maximum speed obtainable with the instruments employed, *e.g.*, the duplexing of the telephone on an overhead line by means of an artificial line, will tax the powers of no mean practician, and in this case a cable would be attacked with far greater ease.

The arms of the bridge may consist of resistances, condensers, or any combination as is well known, and the receiver, R, may be any instrument combined with resistances and condensers as usual.

Fig. 2 reduces fig. 1 to its simple bridge form, and as we

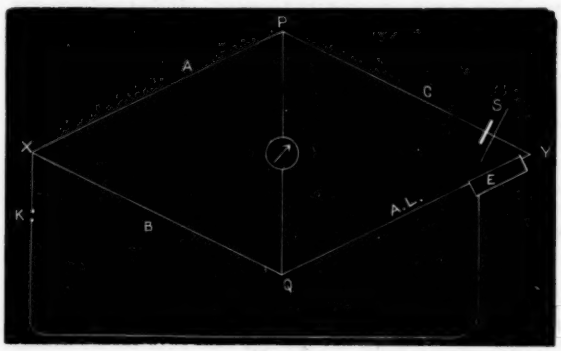


Fig. 2.

are now considering only the received signals at station X, the battery key at X is indicated by K.

Duplex balance having been established at X, we have the relation

$$\frac{X\,P}{X\,Q} = \frac{P\,Y}{Q\,Y}$$

for all conditions of working E.M.F., applied at the point, X, and, therefore, by Sir H. Mance's battery resistance test (*Proc.* Royal Society, January 19th, 1871; Clerk-Maxwell, *El. and Mag.*, art. 357, or any students' text-book), the deflection on any receiving instrument in the diagonal, P, Q, produced by an E.M.F. applied in the branch, P Y (the application of this E.M.F. is what station Y effects by its sending key) will remain unaffected by any alteration of the resistance in the diagonal, X Y; further, as P Q, and X Y, are conjugate, it is clear that the receiving instrument may be put in the diagonal, X Y, and the battery in the diagonal, P Q, without any other alteration of the circuits.

As far as the received signal is concerned, it is, therefore, absolutely immaterial how long the duration of break between the upper and lower contacts of the key, K, is, as also the resistance of the battery; but a further consideration of the subject will show, that what will be affected by these two quantities is, by the former, the balance at the distant end (here, again, the long cable affords the advantage, as it is only on very short lines that the duration of break between the contacts has to be considered), while the battery resistance should be kept as low as possible, in order not to add more resistance than necessary in its circuit.

It is well to remember, in all cases of applied theory, that a signalling key does not send a current, but applies an E.M.F., and consequently the whole of the circuit to which it is applied must be considered in determining the results.

It is easy to show that for maximum obtainable speeds, and with the best conditions of working, the position of the receiving instrument in the one or other diagonal is immaterial, but, at lower working speeds, the receiver should be placed in the diagonal, X Y, to get the largest signals. The expressions for the current in the two diagonals are given in their simplest form by Clerk-Maxwell (*Electricity and Magnetism*, loc. cit.), but, of course, can readily be derived from first principles by any student in electric testing.

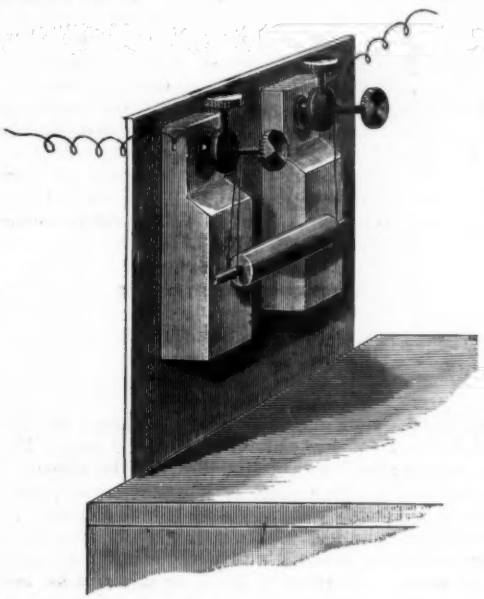
Electric Light at Hull.—The charge per unit is to be reduced from 7d. to 6½d. The price of current for motive power will be 5d. per unit.

AN ADJUSTABLE MICROPHONE.

By W. H. SOULBY.

Though no claim is made to novelty in the following apparatus, yet as it appears to possess certain features which have not hitherto been published, and as experience has proved that the facilities for delicate adjustment are very marked, I have been induced to describe the same.

Firstly, as to the arrangement of the carbons, which are fixed to a small sheet of ebonite about 5 inches × 3 inches, which again is fixed to the end of a sounding box (a cigar box does duty in the present case). Two blocks of carbon, each 1½ inch long by ½ inch thick, are cut down at one end to form a lip or flange, through which the binding screws pass to fasten the carbons to the ebonite sheet. The vertical screws connect the wires conveying the current. The horizontal screws have each a short length of sewing cotton wrapped around them; a piece about 8 inches long is doubled, the two ends being brought together, are placed on the screw, and wrapped round it, leaving a loop of about one inch long hanging down, at the end of which a noose or slip-knot is formed to carry the reduced ends of a small cylinder, or pencil of carbon, about 1 inch long, which remains suspended thereby, and can be raised or lowered by a turn of the screws.



This suspended cylinder of carbon just hangs clear of the fixed carbon blocks. The connecting wires are brought into contact, but no current passes until the carbons are made to touch each other. The sounding box is then slowly tilted up (by means of a wedge pushed gradually under the end of it) till the carbon cylinder rests against the fixed blocks, just lightly enough to obtain the best results, which can be ascertained by placing a watch on the sounding-box, and the receiver to the ear whilst adjusting.

A further adjustment for the strength of current can be made by altering the relation of the carbon block to each other; the binding screws forming a pivot around which they may revolve, when brought closer together more current is allowed to pass, whilst by separating them it is reduced. This arrangement, therefore, provides two adjustments—one for making the contact or connection, the other for regulating the current.

Secondly, regarding the effects produced. The difficulty in this instance was to obtain sounds of a suitable strength, or pitch, to obtain the best effects from so delicate an instrument. Of course a watch was the first sound-producer tested, and when all was quiet, without any other sound or movement near, it answered very well; but the playing of a piano in one part of the house, and the washing of dishes in another, disturbed everything, including the patience of the experimenter. Upon anyone entering the room, walking about, speaking, coughing, touching the table or door handle,

the shriek of the receiver was too much to hear; even at a distance its repeated inarticulate cry became most harassing, though only an ordinary receiver was used. After attaching a longer length of double wire, and retiring to a distant room, the sounds still retained their intensity in the receiver, every word spoken in the other room being recognisable when not too loud, and the ticking of the watch was very distinct, even to the metallic ring of the hair spring as it coiled and uncoiled at its work.

A more delicate and exhaustive test was carried on a few evenings later by the help of an assistant. Having adjusted the microphone to the best angle (by the aid of the watch and receiver), the assistant retired to a distant room with the receiver with instructions to report results. A few words were now spoken near the microphone, but proved too loud to be understood; a lower voice produced the same results; then a whisper; after which, advancing closer to the microphone, a few deep breaths were drawn, and immediately after the first inspiration and expiration the listener called out, "That's splendid, do it again." A few more respirations were taken, when the listener, coming back from the other room, said, "The breathing sounds very distinct, what a chest you have, and how wonderfully deep and hollow it sounds. A doctor could test people's lungs without leaving his surgery, by getting his patients to breathe near an instrument of this kind; every inspiration and expiration was as deep and clear as possible." A further test was shown by placing the hand or bare fore-arm on the sounding box, when a rushing sound was heard, which could be none other than the rapid circulation of blood through the veins. It is also a curious sensation to hear one's own voice in the receiver coming from another source than your own mouth.

Some very successful microphones have been constructed, but considering the cheap and simple arrangement of the one described, the results must be considered very satisfactory. The current was supplied by three small Leclanché cells, the receiver being a small adjustable watch telephone.

PHOTOMETRY.

A series of Cantor Lectures was commenced on Monday night before the Society of Arts by Capt. Abney. He said there was an abundance of literature on the subject of the measurement of light; some of it was very good, some was medium, but some was very bad. He proposed in the lectures to give an idea of the general principles of photometry, restricting himself mostly to the scientific aspect of the question. Photometry in its broadest sense was the measurement of light; he complained, however, that it had come to mean merely the measurement of household light. Now light measured, or the light that a photometer should measure, might be light of two characters; it might be light from a source, or it might be light reflected from a body. Under the first category they had the light from a candle, gas, from the sun or the moon, and they could measure the amount of light coming from each, or, said the lecturer with a touch of irony, "We may think we do." In the other category came the light from white paper, or gray and coloured objects; this was the branch of photometry which had been most neglected, but they would not be successful in measuring any kind of light. When they measured a light they really measured by the illuminating value of it, and by reflection; they measured the amount of light reflected from a screen, but they might have, of course, a variety of coloured screens; but as a rule they confined themselves to what was called white screens. The whiteness of white screens, however, soon disappeared in London. A white screen should be one in which every ray was reflected in exactly the same proportion as that in which it is found in the light which impinged upon it. That was important, because if they looked at a yellow screen, they would find that in the light reflected from that screen, the coloured rays were not in the same proportion as in the light itself. Unfortunately the white screen had yet to be found, for no screen would give absolutely the same proportion of different coloured rays of the light which falls upon the screen. Photometry not only included measurement of the illuminating power of light, but the measurement of light transmitted through bodies of various kinds. The lecturer then passed on to consider the question of the standard of light. Parliament, many years ago, fixed the standard of light, but even an Act of Parliament could not make a light always burn the same. The Act stated that the standard of light was to be a candle, and there were to be six to the pound, and each one was to burn 120 grains of sperm per hour. Unfortunately, however, since this standard was legalised, sperm, on account of chemical improvements, had become so highly purified that it failed to give as good a light as it did when the candle was legalised. The light from a candle was a very pretty thing, theoretically, but, practically, it was anything but pleasant. If they endeavoured to protect it from draughts, by boxing it in, the rapidity of burning was affected, and they did not get the same amount of whiteness, and it burnt most irregularly. By means of an apparatus the lecturer showed on a diagram the irregularity of a burning candle. The apparatus consisted of a revolving drum, on which a piece of sensitised paper was wound. This was placed in a box, the only aperture to the light being a small hole at which the candle was placed; by revolving the drum the irregularities of the light was shown in a streak on the sensitised paper.

Wanted an Unalterable Standard.

What they really wanted in photometry was an unalterable standard, which gave always the same amount of light and the same quality of light. He did not wish to be misunderstood on this point; what they wanted was a light the quality of which remained constant. M. Violle, at the Paris Electrical Congress, some six years ago, proposed, as the standard of light, the solidification point of melted platinum. There were great objections to that, the chief being that it was almost impossible to obtain absolutely pure platinum and impurities, as they all knew, affected the melting point.

The Electric Light as a Standard.

There was one standard, however, which, as far as his experience went, was always the same; that was the electric light. If they measured the intensity of the different parts of the spectrum of the electric light, the proportion of rays was invariably the same. The whitest and hottest part was the crater; this was most uniform in its character. This uniformity was shown by experiments. Commenting on the regularity and constancy of the light, the lecturer said that a square inch of the crater would be equal to 284,000 candles, which was a very good size. The lecturer next proceeded to show the difference of colour in various lights; gas light, for instance, in an Argand light was distinctly blue.

There was, however, no light which could not be matched by a glow lamp, and that was an important point, because he wanted to show by degrees that the whole of the lights he was using were due to incandescent carbon, and nothing else.

The standard must have the same quality and quantity; it was easy to get two lights of the same quantity, but no standard would be perfect unless it was of the same quality. One of the best tests to ascertain any difference in quality was to see, when they were equally strong visually, that they gave the same photographic results. Lights might be visually the same, but not photographically.

This was illustrated by an actual experiment, the shadows thrown by gas and electricity being apparently approximate, but the effects on bromide paper showed a marked difference to exist between the two. He thought the time had come when they must rely on photographic records. A diagram was then put on the screen, which showed how the quality of the light varied in incandescent lamps. As the quantity of energy going through the lamps increased, the rays increased in quite different proportions. Proceeding to discuss the question that all light depended on incandescent carbon, he said if they examined the flame of a candle by the spectroscope, they would see that there was a continuous spectrum, that is, one without any bands in it. Such a spectrum as that could only be due to three things; it may be due to an incandescent solid; it may be due to an incandescent liquid, as molten iron, or it may be due to a gaseous body under very heavy pressure rendered incandescent. Those were the only

three states in which a continuous spectrum could be produced. The only conclusion was that the candle flame was a solid rendered incandescent. It might be argued, how could it be solid when one could pass a finger through the flame? But they may have the carbon in such small particles, that they need not be felt when the hand was passed through. He had found that at any one moment there was about a millionth of a grain of carbon in a candle flame. Other experiments were carried out with special reference to this theory, but we must refer our readers who are interested in pursuing this subject further, to the Cantor lectures, which will be published in the summer months.

The standard of light, in his opinion, must be incandescent carbon; platinum was no good.

Towards the close of his lecture, Capt. Abney mentioned the blackening effects of warmed air. A friend of his, who placed an incandescent lamp near the ceiling, was surprised to find how soon it became blackened. The same thing had been noticed where hot pipes had been used.

ELECTRIC ILLUMINATION.

Prof. Fleming commenced a series of popular lectures on Tuesday afternoon at the Royal Institution on electric illumination. It is evident from the syllabus that Prof. Fleming intends to cover a good deal of ground, his first discourse consisting of varied and interesting topics. He sketched swiftly and boldly the early history of electric lighting in this country; he spoke of the revolution effected by the introduction of the incandescent lamp, and the use of the 1882 Crystal Palace Exhibition as a means of informing the public of the great advances that had been made. The result was that a Bill was passed through Parliament to facilitate the introduction of electric lighting. But from various causes the sanguine expectations formed in 1882 were not fulfilled. The 1882 Bill, however, served the very important purpose of preventing the survival of the unfit. The forward movement was helped by the repeal of one important clause in the Act of 1882, by which more favourable circumstances were created for the inviting of financial support. The lecturer then referred to the Board of Trade enquiry of 1888 in which the whole subject of electric lighting by public supply was thoroughly and carefully debated by the leading experts. Up to the date of this enquiry the capital invested in electric light undertakings was, comparatively speaking, small; after that it advanced by leaps and bounds. Diagrams were projected on the screen, which showed the increase in the number of lamps during the past two or three years. Comparing the present position of electric lighting with gas he found that 63 millions sterling represented the paid up capital of the gas undertakings. In 1893 the gas companies supplied altogether about 100,000 million cubic feet of gas. The gas supply represented a lamp connection of about 100 million 8-C.P. Prof. Fleming then went on to describe in popular language the definition of fundamental terms, the units of measurement, the Board of Trade units, and so on. Afterwards he dwelt to a considerable extent on the radiation from incandescent bodies, temperature of radiant bodies, methods of photometric comparison, and luminosity and candle-power.

OPENING OF THE NEW ELECTRICITY WORKS AT COATBRIDGE.

On the invitation of the directors a select company repaired to Coatbridge on Saturday afternoon last, to witness the inauguration of the undertaking. The ceremony was performed by Lord Kelvin, in the presence of a large and representative assembly of spectators, amongst whom were Major-General Webber, Sheriff-substitute Mair, Prof. Jamieson, Mr. T. Bost, chairman of directors, and Mr. Angus Macleod, managing director of the House-to-House Company, together with Bailie Colquhoun, Messrs. Cairney, Hannay and Flett, directors of the company, Mr. David Black, the secretary, Mr. Wm. A. Bryson, the consulting engineer, and Mr. Francis Teague, resident engineer. The contractors were represented by Mr. John Kerr, managing director, and Mr. Hartley, manager to Messrs. Dick, Kerr and Co, Limited, Kilmarnock, and by Messrs. W. M. Mordey, W. Geipel and Hall, of the Brush Electrical Engineering Company. Amongst the general company were Bailies Burt and Paton, Councillors Hamilton, Angus Campbell, and Mayberry, all of Glasgow; Bailies Sharp and Davidson, Mr. J. M. Alston, Town Clerk, and Mr. Gemmill, Town Chamberlain of Coatbridge, the Town Clerk of Ayr, Mr. W. Elsdon Dew, of the Kelvinside Electricity Works; Messrs. Maclean and Meikle, assistants to Lord Kelvin; Mr. T. Crichton Fulton. Perhaps the most suggestive figure in the whole company has been omitted from this list—Bailie Bird, the chairman of the local gas company, who, after fighting the electric light company to the last gasp in London, like a sensible man accepted the situation which he was powerless to alter, and came to witness the birth of the undertaking which, without a doubt, is destined in the near future to be a very formidable and successful rival.

It was not merely a bold, but actually a master stroke of policy on the part of the directors to capture for the day's proceedings the venerable Professor of Natural Philosophy. That Lord Kelvin, the strenuous advocate of low tension continuous current distribution should have been prevailed upon to inaugurate a high tension alternate current station argues an occasion of more than ordinary interest; and, indeed, the station is unique in this respect; it is the only one in Scotland in which distribution is effected by means of alternating currents of high tension. The use of gas engines for central station work is not by any means a novel idea, for Prof. Jamieson, and Mr. Foulis, gas engineer to the Glasgow Corporation, recommended the adoption of this system some years ago for the Glasgow public electric supply.

The first part of the ceremony consisted in the photographing of Lord Kelvin with the directors, officials, and chief guests, after which the formal opening was performed by Lord Kelvin starting one of the engines. That being accomplished, and every part of the working having been explained to his Lordship and his followers, the general company were invited to make an inspection of the whole plant and premises by the chairman, Mr. Bost.

By the time this was ended the cravings of nature, which interest and curiosity combined had hitherto managed to stifle, began to assert themselves, and an adjournment was made for lunch, the warmth of the invitation making ample amends for the coldness of the viands.

The inner man having been appeased, the outer man waxed loquacious, and begun to make speeches. These were all couched in the usual congratulatory terms, as a matter of course. But beneath the mere surface gloss of compliment, there ran throughout all the remarks of the various speakers an undercurrent of opinion, more implied than uttered, that the occasion marked an era in electric light work, and that the new departure so successfully inaugurated was destined to have momentous consequences. If it succeeded there would be many imitators; and if it failed, which every speaker most devoutly hoped it would not, it would serve as a warning to all engaged in like work.

The first speaker was Mr. Bost, the chairman of the directors, who briefly thanked Lord Kelvin for the honour he had done them by his presence and services, and proposed the toast of his health. Lord Kelvin, in responding, was hailed with cheers, and said that he was exceedingly pleased to be present and to inspect the works. He hoped the light would be a very great boon to Coatbridge, and that the example would be followed by many other places throughout the land. He even went so far as to think and hope that the electric light would take the place of all the illuminants which had been used since the beginning of the world. The system of distribution adopted, he thought, was a very suitable one for Coatbridge, which had numerous villages and large public works within a radius of a few miles, and he trusted that the House-to-House Company, who had worked this system with success in other places, would find it equally profitable in Coatbridge. But, he went on to say, there was another feature about the station which, without using too large a word, might be found to have an interest for the whole civilised world in both hemispheres, and that was the

use of gas engines. It would be premature to say yet what the results would be, but he thought they had all seen enough to form the most sanguine expectations. He paid a high compliment to Messrs. Dick, Kerr & Co., of Kilmarnock, whose gas engines should have been the very first to realise ideas which have been put forward by many notable men, including Sir William Siemens, who gave a lecture on the subject in Glasgow 12 years ago. All that the lecturer had then said had been here realised. He hoped the same principle would soon be attained with regard to the generation of electricity, so that it would no more require a formidable array of furnaces and apparatus, but could be got in such a quiet way that they could perceive nothing but the outsides of the machines from which poured such tremendous energy. He considered that the practical economy of the system was exceedingly good, and that the Scottish House-to-House company were deserving of all praise for the bold and courageous step they had that day taken.

Dr. Colquhoun then proposed "The Provost, Magistrates, and Town Council of Coatbridge," to which Bailie Chisholm replied. Prof. Jamieson next gave the toast of "Success to the Scottish House-to-House Electricity Company," and said that the company had taken the initiative in a daring and novel departure from anything hitherto attempted in the supply of electricity. They had done away entirely with steam engines and boilers, with their dirt and other disagreeable features, and had gone in for the more efficient and cleanly gas engines. He called special attention to the fact that the gas engines they saw at work that day, by having two cylinders with cranks coupled together, and each cylinder being double acting, they had the same conditions as were obtained with steam engines, viz., an impulse every stroke, with consequent steady working. He thought it was a pity Prof. Forbes was not there that day to witness how successfully Mordey alternators could play in parallel. He coupled the toast with the name of Mr. Angus Macleod, the managing director, to whom much of the success of that day was due. Mr. Macleod briefly replied, thanking the company for their presence, and for the kindly expressions of congratulation and goodwill to which he had listened. The directors, he said, would leave nothing undone to make the experiment the success which it undoubtedly deserved to be.

In the evening a select company dined with Mr. Macleod in the Royal Hotel, which was one of the first buildings in Coatbridge to be fitted for the electric light.

Altogether, the proceedings were of a most successful and agreeable character, and every man seemed to be better pleased than his neighbour with what he saw. Of course, now and then one came across a caviller whose chief end it was to find fault; but that is the sort of man who forgets that even the sun has his spots. Much of the pleasure was derived from the courteous way in which the representatives of the contractors and the members of the resident staff answered the numerous questions of even the most troublesome "anxious inquirer."

The immediate prospects of the company are certainly of a roseate hue. The makers of the gas plant, Messrs. Dick, Kerr & Co., have guaranteed that their fuel bill shall never exceed 10d. per equivalent of 1,000 cubic feet of ordinary lighting gas of good quality; the gas in Coatbridge is not of the *very* best quality, and costs 3s. 6d. per 1,000 cubic feet; the electric light company are supplying electricity at 5d. a unit, and they are beginning their business with considerably more than half their possible number of lights already booked. What more could any company desire—for a start?

PROMISING FOREIGN MARKETS.

The recent protracted period of unsatisfactory trade has led many firms in the engineering and kindred businesses to seek out fresh markets for the profitable disposal of their manufactures. With the development of our colonies there is, of course, a proportionally increased opportunity for enterprising British engineering and electrical firms to push their goods, as much as for other classes of trade. Colonial trade, moreover, is materially supplemented by the extensive markets which have of late years been opening up in Brazil and certain portions of Africa. As regards the former, trade has been for some time practically at a standstill, so far as we are concerned over here, but there now seems every probability that the long hoped-for settlement between the contending political parties in Brazil has been arrived at, and in the event of such being the case, there will shortly be a splendid market. It will, however, be necessary for firms commencing business negotiations with parties out there to have their wits about them, especially if they are inexperienced as to Brazilian methods of doing business. There is undoubtedly plenty of room for development in that part of the world when the affairs of the country are completely re-established on something of a reasonable basis.

The Continent of Africa, however, is now, and will be, more hopefully looked to as a promising field for British commerce, and with a certain amount of justification, for with the work of progress and civilisation that has been going on of late years—more particularly within the past 12 months in the central and eastern districts—the prospects are of the most promising, encouraging, and even alluring character to capitalists and traders alike. The work of development and opening up will naturally create a very extensive field, and the richness of the cream will be appropriated by the first to open establishments there. While it is preferable to have one's own establishment directly under the supervision of a special representative in the vicinity, it is a large expense, and some firms will be unable or indisposed to venture to that extent in expenditure at first. For such firms a method for, in a measure, overcoming the difficulty, has been instituted by Messrs. Hannan & Son, of Leadenhall Street, E.C., and Johannesburg. By arrangements which they are making, it will be possible for anyone to be represented there by a permanent exhibition of their goods, without going to the expense of a special establishment. At Johannesburg there is to be started by Messrs. Hannan a permanent commercial exhibition of samples and specimens of British goods and manufactures. Space in this exhibition will be let at a certain charge per foot frontage, which will include the cost of keeping exhibits in order, and a page of description in the catalogue of the exhibition. We do not for a moment attempt to say that a stand at the Johannesburg Exhibition would be equal in results to a special establishment, but stands would meet the purpose of such firms as we have referred to above.

There is one point in regard to this exhibition upon which we would like to make a suggestion to the promoters. One of the greatest errors into which exhibitors of machinery fall is that of leaving in charge of their stands a commonplace labourer, who knows nothing about the apparatus beyond the manner of cleaning it, and therefore, in the event of spectators inquiring for information regarding the working, they are informed that there is no one there able to afford them any particulars. That kind of reception is not likely to lead to business. We commented upon this matter last year in regard to the Chicago Exhibition. The following is an extract from our remarks at that time, and we fully endorse them now:—

> Many of the electrical exhibitors at the Chicago Exhibition have either left no one at all in charge of their stands, or, what is more frequently the case, they have left their entire exhibit in the hands of a general labourer, who is almost entirely ignorant of the working of the apparatus, and perhaps even the names of the articles on show. It is too often the case that exhibitors are satisfied with the attendance of some individual for the mere purpose of cleaning their exhibits and seeing that they are not interfered with by spectators or others. Our New York contemporary, the *Electrical World*, calls this a short-sighted policy, and such it undoubtedly is. A mere sight of the things may be satisfying to the disinterested non-technical visitor, but the technical man and the student desire to examine the general and detailed working, construction, and so forth, of the apparatus. There are, it is said, perhaps a dozen exhibits of merit in the Electricity Building where no attendants at all are to be found. Of course it is very bad policy on the part of exhibitors, as they will be the losers in the long run, by neglecting to turn to good account what might otherwise prove profitable business.

We would recommend Messrs. Hannan to see that technical men are engaged in the machinery sections, more particularly the electrical portion. We would also advise intending exhibitors to see that their interests are not neglected in the way referred to above.

Messrs. Hannan have issued various prospectuses and papers regarding the trade prospects in South Africa, and any further information will be afforded by them.

REVIEW.

The Engineer's Year-Book of Formulæ, Rules, Tables, Data, and Memoranda. By H. R. Kempe. London: Crosby Lockwood & Son.

In the preparation of a book containing so enormous an amount of information as does this year-book, the chief difficulty must be in selecting the material.

Mathematical tables and concise formulæ for plane and solid mensuration properly find a place in such a volume, and the tables are particularly well printed. We are, however, disappointed in the section on steam boilers: it is misleading. How does it happen that a Lancashire boiler 30 feet by 8 feet 6 inches is credited with 390 horse-power capacity and a Galloway boiler of equal size is credited with 450 horse-power. Every practical engineer knows that of the two the Lancashire boiler is certainly not second, and that for modern pressures the non-circular flue of the Galloway boiler is far from being a mechanically sound construction. Not content with these two tables, there is a third which rates the Lancashire boiler at only about one-third the horse-power of the other tables. With engines using 20 lbs. of water per horse-power-hour the Lancashire boiler will be found capable of quite 400 I.H.P.

Similarly, some revision is required in the section on flour mills and cotton mills. The information in this section is much of it quite out of date, as also is that on proportioning toothed gears.

On the other hand there is given, probably for the first time in a book of this description, information on air compressing, on hydraulic hoists, &c., turbines, refrigeration, pneumatic dispatch, gas and petroleum engines, which must enhance its value very considerably.

There may be, and doubtless are, many other blemishes which could be pointed out by experts in each particular subject, and such criticism is invited with a view to the elimination of faulty or out-of-date information, it being intended to issue the volume every year, the present being the first year of publication.

We think it would add considerably to the value of the information if more references were given to the authors or to the date of the original publication of the various items. This would be particularly valuable to such engineers who, not having a close acquaintance with the subject in hand, might, at least, have some knowledge of the original investigator and his work. For example, Fairbairn's rule for the collapsing pressure of cylindrical flues is credited to Fairbairn. This rule is wholly unreliable to-day, and should have been so stated. The fact that it was Fairbairn's tells the reader, however, that it must be an old rule and prepares him to expect that modern practice has developed something different.

CORRESPONDENCE.

Electric Lighting of Steamships.

Permit me a few words in defence of my use of terms in the articles on "Ship Lighting," and also of my suggested rules; your leading article and Mr. Sam Mavor's letter both refer to these points. First, then, it will be observed, on careful consideration, that the rules have for their primary object the suppression of the indiscriminate use of that favourite jerry material, *wood casing*, and the compulsory use of *metal casing*. Now if we put a single wire system into a metal casing, it is still a single wire system, even if we take advantage of the conductivity of the metal casing and attach the return leads to it, it is still a single wire system. Because a concentric wire forms the most convenient and cheapest single wire system with a metal casing, that, in my opinion, does not make it anything but a single wire system; it cannot be anything else so long as there is only one insulated conductor, the casing being earthed.

The concentric system pure and simple requires both outer and inner conductor to be insulated from each other and from earth. According to my rules this system would require a further external metal casing, and it is so used in practice with wood casing. I advocate the use of a single wire system in metal casing, a concentric being the handiest material for the purpose; but it is, in my opinion, a gross misuse of terms to call a single wire system a concentric system because a metal casing has been substituted for a wood casing. A double wire system in metal casing is used regularly in the Admiralty work; that also would be called a concentric system according to the views of the writer of the article, if he is consistent, but it is not a concentric system any more than a single wire in metal casing.

Secondly, the rules most certainly do not prohibit the use of single wiring; they rather encourage its use. What they do prohibit is the use of wood casing, and allow the free use of single wiring in metal casing. And, having a metal casing running parallel with the single wire, the use of the hull for fixing return wires is not necessary; they can be fixed to the casing.

Any bitterness which may have been imported into the discussion has arisen from your correspondents taking advantage of your columns to attack myself and Mr. Andrews, by naming us in connection with work which they allege had been carried out by us. Having allowed these correspondents this liberty, I might have taken or been allowed the same. But the question before us was not one concerning work done in the past by anyone, and, therefore, I think it was unfair to allow any names to be used at all.

Rankin Kennedy.

With reference to Mr. R. Kennedy's letter and paper in your last issues, I should like to state that the single or double-wire system in wood casing is good enough and proper in some parts of a ship, whereas, in other parts, iron pipes or lead-covered armoured cables must be used. But, as every practical man knows that the fewer joints an installation on board ship has, the better and safer it is, why not do away with that jointing system and use the distribution system only, as pointed out in Electrical Review, February 16th, 1894, page 179?

Main branches to supply the distribution boxes may be clamped or jointed on the mains (the latter preferable) and properly insulated in convenient and protected places; and joints in iron pipes are not required, being a practice of days gone by.

Coming to methods or systems, we should divide them into two distinct systems, the single and the double-wire system.

I.—*Single-wire System.*

Single-wire in wood casing.
Single-wire distributed. Single-wire jointed

Single-wire in iron pipes.
Single-wire distributed. Single-wire jointed not suitable.

Single-wire lead-covered in wood casing or clipped.
Single-wire distributed. Single-wire jointed.

Single-wire armoured (so called concentric.)
Single-wire distributed. Single-wire jointed.

Single-wire lead-covered and armoured.
Single-wire distributed. Single-wire jointed.

II.—*Double-wire System.*

Double-wire in wood casing.
Double-wire distributed. Double-wire jointed.

Double-wire in iron pipes, two separate pipes.
Double-wire distributed. Double-wire jointed not suitable.

Double-wire lead-covered in wood casing or clipped.
Double-wire distributed. Double-wire jointed.

Double-wire armoured (so called concentric.)
Double-wire distributed. Double-wire jointed.

Double-wire lead-covered and armoured.
Double-wire distributed. Double-wire jointed.

Double insulated concentric, lead-covered double insulated concentric, lead-covered armoured double insulated concentric, parallel twin, twisted twin lead-covered or flexible, should be used for masthead lights, compass lamps, portable lamps, or cargo clusters.

The best results regarding safety and economy have been

attained by using the single-wire distribution system in wood casing and iron pipes, and the double-wire distribution system in wood casing and two separate iron pipes running parallel.

Leon H. Cline.

In reply to your leader of March 30th, and Mr. R. Kennedy's letter of March 2nd, which was left unanswered to await the completion of his series of articles, I am surprised that Mr. Kennedy's wide experience has not brought him in contact with electric light circuits on ships which carry at least 100 ampères. On about 30 ships in which I have fitted complete electrical gear, there have been very few which have not circuits running nearly the whole length of the ship, carrying more than 100 ampères, especially where search lights are fitted, and these should not be omitted when an attempt is made to lay down rules for electric lighting of steamships. Therefore I fail to see why the standard taken in my experiments at the Elswick Works does not approximate to actual practice.

Mr. R. Kennedy also says he has not heard of 200 lamps being run off one main. I fail to see why this number is mentioned, as 200 lamps of 16 C.P. at 80 volts, would require about 160 ampères; or 200 lamps of 16 C.P. at 65 volts, would require about 200 ampères.

In my trials I used a current of 100 ampères, which, as before stated, is often carried in one pair of mains, to feed 125 lamps.

In Mr. R. Kennedy's third article, he states that in double wiring, if one wire becomes earthed, the other arrives about the same time. This has not been my experience. Generally, faults only occur when damage has been done to the cable by a screw, nail, or a faulty joint; and if the fault occurs in one wire owing to these causes, it does not follow that the other should give out.

Reliable supervision, and a system of double wiring, lead-cased cables, carefully laid and fixed securely on flat teak battens throughout their whole length, watertight lead-covered joints and watertight fittings have proved themselves, time after time, most reliable, and undoubtedly warrant the small extra cost of fitting.

L. Newitt.

A New Key for Lamp-Post Switches.—The following postscript should have been added to Sir David Salomons's letter, which appeared in our last issue:—"In many forms of switches it would be possible, at a small expense, to place a spring (spiral by preference) in such a manner as to drive any key out of the switch in the same way as if the spring were inserted in the key itself."

LEGAL.

Dickinson *v.* Scott.

Last Monday, at the Stockton County Court, before His Honour Judge Turner, Mr. Thomas Dickinson, building contractor, Middlesbrough, sued Mr. Ronald A. Scott, of Acton Hill, for £20 10s. for work done. The case for the plaintiff was that in May last the defendant arranged with his agent, Mr. W. C. Folchard, of Stockton, to have two displays at Middlesbrough of his patent electrical apparatus for advertising on the clouds with a view to selling the patent rights for the six northern counties to a syndicate, which Mr. Folchard and Mr. Fred Forster were to get up. The plaintiff put up the staging, &c., for the displays, and assisted to erect the machine and also take it down, but neither Mr. Folchard nor the defendant had paid him. An offer of £4,000 was made for the patent rights, and Mr. Folchard was to have 5 per cent. commission, but Mr. Scott wanted, in addition, a royalty of £4 per lamp per annum, and the negotiations fell through. The defence was that Mr. Folchard was liable, and the defendant, on a counter claim, sought to recover £50 damages for loss of profits arising from the wrongful detention of the machine by the plaintiff. His Honour, after a long hearing, found for the plaintiff for £12 and costs, and against Captain Scott on his counter claim.

Elmore's Foreign and Colonial Copper Depositing Company.

In the Queen's Bench Division of the High Court, on Wednesday, Mr. Justice Vaughan Williams sitting as an additional Judge in Chancery, had before him the petition of Sir J. R. Meade for the winding up of Elmore's Foreign and Colonial Copper Depositing Company, Limited. Learned counsel who appeared in support of the petition said that since the matter was last before the Court, the petitioner had died, and his executors had not yet proved his will. They desired time to consider what course they would take with regard to the petition, and he asked that the matter should stand over for a month. His Lordship agreed to this course.

Brown *v.* Gustavus Brothers.

At the Swansea County Court on 30th ult., before Judge Gwilym Williams, a remitted action was heard, in which Mr. J. Brown, electrical engineer, claimed £110, the price of a gas engine supplied to Messrs. Gustavus Bros., builders. There was a counter claim for £28, representing £13, the cost of supplying and affixing a "Stockport" self-starter to the engine, and the balance for breach of agreement. A sum of £92 had been paid into Court by the defendants in satisfaction of the claim. After a lengthy hearing his Honour gave judgment for the plaintiff for £110 (including the £92 amount paid into Court) on the claim and counter claim, with costs.

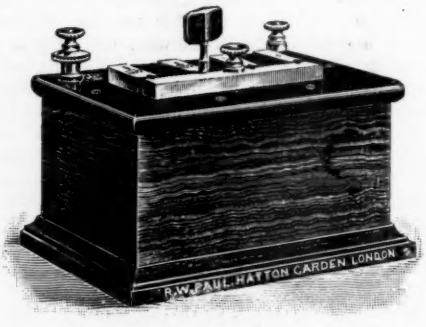
Maquay Electric Light Company *v.* V. F. Wilde.

On Wednesday, in the Westminster County Court, before Judge Lumley Smith, Q.C., this case was heard, and was a claim for £6 5s. for goods supplied to the defendant. The plaintiff's case was although two portions of goods were sent to Mr. Wilde at Blackpool and Macclesfield, the rest were supplied to the defendant. The defendant said he was only liable for 34s.; it was his brother who owed for the remainder. His Honour gave judgment for the plaintiffs for the amount claimed, with costs.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's) for 1894.—Published by H. Alabaster, Gatehouse & Co., 22, Paternoster Row, London, E.C. This directory comprises the names of 18,414 different individuals and firms, is divided into four sections, namely, British, Continental, American and Colonial, each of these being sub-divided into alphabetical and classified sections. There are about 800 pages consisting entirely of directory matter, making the book the fullest, as it is the oldest, electrical directory in the world. The price of the work is 4s., post free.

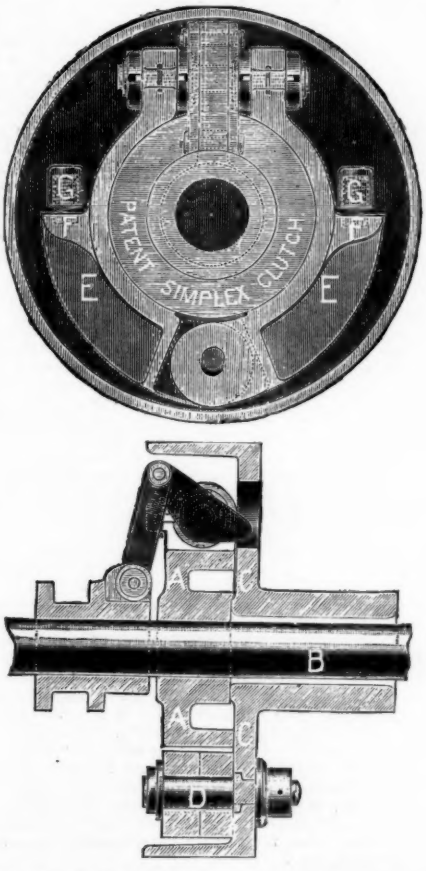
Universal Shunt Box.—On another page we publish Prof. Ayrton and Mr. Mather's paper on a "Universal Shunt Box."



The instruments are made by Mr. Robt. W. Paul, of 44, Hatton Garden, E.C. This illustration gives a general view of the apparatus.

Hanley Tenders.—In a recent issue we stated that Messrs. Spagnoletti & Crookes had secured the contract for electric light wiring and fittings to Corporation buildings. We are now in a position to give particulars of all the tenders sent in for the work, *i.e.*, C. A. Hemingway, £5,681; Crompton & Co., £4,925; Harry South, —; Charles Smith & Sons, £4,159; Joseph Blackburn, —; Laing, Wharton & Down, £4,152; A. H. Wood, £4,121; E. M. Evans, £4,086; J. Defries & Sons, —; Bourne & Grant, £3,986; Thomas Barton, —; Brush Electrical Engineering Company, £3,980; Paterson & Cooper, £3,915; W. A. Shaw & Co., £3,897; Graham & Biddle, £3,873; Lea, Sons & Co., —; R. Barnett & Co., £3,865; Sharp & Kent, £3,859; H. F. Joel & Co., £3,789; Fowler, Lancaster & Co., £3,711; Marryat, Lillywhite & Co., £3,726; J. C. Collum & Co., £3,657; Walsall Electrical Company, £3,657; B. Verity and Sons, —; Johnson & Phillips, £3,657; New & Mayne, £3,611; Manchester Edison & Swan Company, £3,585; Donnivan, Parminter and Barber, —; Maunsell, Mercier & Co., £3,527; Baxendale and Company, £3,445; S. H. Haywood, £3,061; J. D. F. Andrews & Co. (to different specification), £3,047; Spagnoletti & Crookes (accepted), £3,034. Where no amounts are entered, tenders were sent for some of the buildings only. Highest tender, £5,681; lowest tender, £3,034. There is an almost incredible disparity between these figures. We should feel interested to know what causes the great difference. Superior class of work and quality of material could hardly account for the £2,647 difference between the lowest and the highest estimates. If all tendered for similar specifications, the inferences are obvious.

The Patent "Simplex" Clutch.—In connection with the driving of mills and workshops, where it is desirable to stop any portion of a line of shafting or an individual pulley, and to set the same in motion again, it is of the greatest importance to select a simple and efficient means for the purpose. For attaining this object the use of friction clutches, in place of fast and loose pulleys with shifting belts, has now become very general, and, where suitably applied, their adoption has effected a considerable saving both in time and power. An increasing demand for the latter has consequently arisen, and much interest is manifested in their manufacture. The Unbreakable Pulley and Mill Gearing Company, Limited, have now for some time been carefully investigating the merits of various systems of friction gear with a view to taking up this branch of manufacture, and, as a result of frequent tests and experiments, they have adopted the type which we illustrate, and which is known as the patent "Simplex" clutch. The principle in this clutch is of the ordinary hand-brake type acting on the outside of a disc keyed upon



the shaft. The band is in two segments, and is so arranged that when not grasping the disc it is prevented from touching it at all. The clutch, which can be used as a friction coupling for shafts, as well as in connection with rope and belt pulleys, consists of a disc, A, which is keyed upon the driving shaft, B; also running loose on the driving shaft is the disc, C, and fixed upon this disc are two straps, E, E, by means of the carrier pin, D. These straps are opened and closed by means of the right and left hand screw at the opposite sides of the centre to the drive pin, D; and the straps are also provided with lugs, F, F, or projections, which engage with spiral springs contained in the pockets, G, G, which are cast in the disc, C. The object of this arrangement is to ensure the friction straps being thrown quite clear of the driving disc in any position the clutch may stop in. The hole in the friction straps, which fit on the carrier pin, D, are made oval, so that as the straps wear away they are free to engage with the driving disc, allowing a large amount of wear. The right and left hand screw is worked by the ordinary sliding boss lever arrangement.

Weybridge Electric Lighting.—Last week Mr. Henry Yool reported to the Chertsey Rural Sanitary Authority that the Lighting Inspectors were desirous, having regard to the unsettled state of local government, to renew the contract for lighting the village by electricity, although difficulties had arisen with regard to the overhead wires. The company were really under a daily penalty at the present time for not removing the wires, but the Lighting Inspectors asked that the contract should be renewed for 12 months. He moved that the authority should sanction the proposal, and undertake not to bring any action with reference to the removal of the wires until September 29th, 1895. The resolution was carried.

Preston Lighting.—A petition has been presented by the National Electric Supply Company, praying to be heard in opposition to the Preston Gas Bill.

Cheltenham Electric Lighting Tenders.—The following are the tenders received for the electric lighting installation, and some notes of the committee thereon:—The plant for which tenders were required included two complete steam alternators, each 33 kw. output, one complete steam alternator of 110 kw. output, and one steam boiler and condensing plant. Six firms tendered for the whole of the work as follows:—

Laing, Wharton & Down (B and L)	£4,964
Siemens (Belliss, D)	4,360
Siemens, Bros. & Co. (Willans, D)	4,610
John Fowler & Co. (Fowler, R)	4,500
Johnson & Phillips (B and L B)	4,307
Crompton & Co., Limited (B and L R)	4,100
" (D P and R)	4,125
" (Belliss, R)	4,180
" (Belliss, D)	4,170
" (Willans, D)	4,470
Brush Company (Brush, D and R)	3,840

Two tendered for the boilers only, viz.:—Galloways, Limited, £438 15s.; Spurr, Inman & Co., £340.

Four tendered for the steam alternators only, viz.:—Willans (Willans, D), £3,963; Electric Construction Corporation (D), £3,400; McLaren, J. (McLaren, R), £3,322 10s.; Mather & Platt, £3,255 10s. 6d.

Note.—B and L, is Browett and Lindley engines; D, is direct-driving; R, is rope driving; B, is belt driving; and D P, is Davy-Paxman.

Taking the tenders in the above order:—

Laing, Wharton, & Down.—Is generally in accordance with the specification, though some matters are left in doubt. The boiler provided is small for the required duty.

Siemens, Bros.—The boiler is of the ordinary Lancashire type, but will not guarantee the required efficiency. Since the minute of the Committee of the 20th ult., the Committee have inspected the installation of Messrs. Siemens Bros. & Co., at Bristol, and found it to be satisfactory.

John Fowler & Co.—The engines are of the horizontal type with rope driving, involving an engine room 54 feet in width, and adding 30 per cent. to the cost of the building, and therefore increasing the tender for comparative purposes to nearly £5,000.

Johnson & Phillips.—The boiler is of the ordinary Lancashire type, and rather small for the required duty. The specification is incomplete, especially in regard to the electrical portions of the work.

Crompton & Co.—The boiler to be made by Messrs. Danks & Co. who will not guarantee the required efficiency. Five alternative tenders are submitted for the engines, three being rope driving and two direct driving. The alternators are not guaranteed to be in accordance with the specification.

The Brush Electrical Engineering Company, Limited.—Offer a boiler by either Tinkler & Co., or Danks & Co., of the same size as Messrs. Crompton & Co., but without any reservation as to guarantee of duty. The large steam alternator to be direct driving, and the two smaller ones to be rope driving. This tender is the lowest.

Galloway's, Limited.—Tender for a Galloway boiler of the same size as many of the other tenders, but with 28 Galloway tubes in the flue. This tender is the only one which is guaranteed to pass the specified evaporation test. The Galloway boiler is one of the most efficient known, the construction is such that almost every operation in the manufacture of it is performed by machinery, avoiding the imperfections inseparable from hand work, and thus obtaining the greatest security against possible accident.

Spurr, Inman & Co.—Tender for an ordinary Lancashire boiler, and say that they are not prepared to comply with the guaranteed duty required by the specification.

Willans & Robinson, Limited.—This tender is the same in every respected (except price) as that of Messrs. Siemens Bros

The Electric Construction Corporation.—Tender for direct driving engines, but do not agree to the month's trial run specified, and offer only six hours' full load trial run. The connections between the alternators and switchboards are not included.

J. & H. McLaren.—Tender for the same electrical plant as the foregoing, but driven by horizontal rope driving engines instead of vertical direct driving.

Mather & Platt, Limited.—The tender is not accompanied by a detailed description, and therefore is not in accordance with the specification.

The tenders are remarkably near each other in amount, and all are well within the original estimate.

The Committee have on several occasions seen Willans' engines at work and from the information which they have acquired in their visits to other stations, especially at Bristol, they have come to the conclusion that, taking all the circumstances into consideration, the efficiency required will be best secured by the selection of the Siemens's tender, although it is not absolutely the lowest.

The recommendations of the committee have been adopted by the Council.

Church Lighting.—The Vicar of Leeds Parish Church recently expressed the hope that in the course of the year the church would be electrically lighted.

Messrs. Maunsell, Mercier & Co., of Manchester have been entrusted with the electric lighting of the Methodist Free Church, Blackpool, from the Corporation mains. This is said to be the first church to be electrically lighted in Blackpool, and the installation will consist of 4 7-light electroliers, 3 4-light electroliers, and about 30 single lights all of 32 candle-power.

Town House Lighting.—Messrs. Drake & Gorham have secured the contract for the wiring of two new houses in Melbury Road, Kensington, which have just been erected, the number of lights being 150.

The Electric Lighting at Bedford.—The question as to who are the best persons to carry out the electric lighting of Bedford has been debated with considerable vigour in the past. It will be remembered that an electric lighting company was formed for the purpose of inaugurating a public supply, but the Corporation pursuing a dog-in-the-manger policy would neither approve of the company carrying out the work, nor would they undertake to do it themselves. The result has been that the whole matter was brought before the Board of Trade last Friday, there being three deputations present to urge their respective views as to who were the proper parties to supply that borough with electricity. Mr. Coward, barrister, appeared on behalf of the Corporation; Mr. Sydney Morse represented the Bedford Electric Lighting Company. A ratepayers' committee, which had been formed to prevent the Provisional Order held by the Corporation falling into the hands of the company, was also represented. After the representatives of the various interests had stated their cases, Sir Courtenay Boyle addressed the meeting He said that he thought this was one of the cases where it would be better that the decision of the Board of Trade should be communicated at once. Therefore, he was in a position to state what the advice will be that they would give to Mr. Mundella, and if Mr. Mundella concurred that would be the decision of the Board. The primary interests that will have to be consulted are the interests of the ratepayers. The Board of Trade are glad to develop trade, and facilitate the efforts of such companies as Mr. Morse represents, but the principal parties to be considered by the Board of Trade are the ratepayers. In order to get at the views of the ratepayers of the borough of Bedford, the first persons to consult were the Corporation, and they had the firmest possible reliance in the wisdom and discretion of the Corporation. But the Corporation have had an Electric Lighting Order since August 4th, 1890, and not done anything under that order at present, except to give to the difficulties of the situation their careful consideration. The time must come when consideration is not sufficient and some definite action must be taken, and it seems as if the time has now arrived when, in the interests of a large section of the ratepayers of Bedford, some definite steps should be taken. If the Corporation will act upon their order, and will undertake to do something to show that they really intend to carry out their powers, the Board of Trade will be very loth to interfere with those powers. Therefore, that would be his first advice to Mr. Mundella. If the Corporation will, as soon as they can, pass the necessary resolution to supply electricity within the compulsory area proposed in the company's order, their assent will not be dispensed with and their order will stand, but if they will not so resolve, their consent will be dispensed with and an order will be granted to a company. The ratepayers' interests will be safeguarded, because the Corporation's order will not be at once revoked. The compulsory area will be open to reconsideration, so that if the company get the advantages for which they contend, they shall be liable to supply at once, or within the compulsory time, a rather more extended area than has been suggested. Something has been said about the position of the company. There was nothing to show that the company will not be able to satisfy the Board of Trade as to their ability. If the company do not satisfy the Board of Trade within six months as to their ability to carry out their powers in the compulsory area within the limited time, or if they do not conform to the terms as to the compulsory area, their order will be revoked. There is now an opportunity given to the Corporation to decide aye or no whether they will do something or agree together on doing nothing. If they do something their powers will stand, but if they do nothing they will forfeit their powers.

The following is the text of order since forwarded by the Board of Trade, from which it will be seen that the time allowed to the Corporation, as which to start their works, is extended to the end of the present year:—"Board of Trade, Bedford Electric Lighting.—If the Corporation will at once resolve to carry out supply in company's compulsory area before January 1st, 1895, Corporation order will stand and their assent will not be dispensed with. If not, assent will be dispensed with, and order granted to company. But (1) Corporation order will not be revoked; (2) Compulsion area will be open to consideration; (3) Unless company satisfy Board of Trade within six months as to their ability to carry out their powers, their order will be revoked, or if they do not comply with the terms of the order. In such case the Corporation order will remain. If they do satisfy and do carry out, order of Corporation will be revoked.

Cherryhinton and Electric Lighting.—A meeting at Cambridge last week discussed the advisability of forming a company for supplying the parish with the electric light. Lord Russell, who was present, said they proposed at first to put down one boiler, one engine, and one dynamo. The whole of the plant and machinery, the building, the land, and the mains and transformers to the various houses, could be put down for between £2,500 and £3,000. Speaking of his own firm as contractors, he said they were willing to take about 50 per cent. of their contract in debentures. They would at present require a sum amounting to about £2,000 by subscription. They would be able to supply 500 lights with the sum mentioned; that was as much as they could expect to have taken up in the first six months. They would charge 8d. a unit at first for the electric light. The meeting was ultimately adjourned, a committee being appointed to make enquiries as to the probable consumption, and as to the probable financial support the proposed company would receive.

Coatbridge Electric Lighting.—Messrs. Anderson and Munro have been instructed to execute the wiring for the electric lighting of the offices of the Master of Works, Registrar and Chamberlain, for the sum of £17 10s. The same firm submitted to the Town Council last week designs for the electric lamps for the Town Hall, Council Chambers, Public Offices, &c., which were approved of.

Dublin Electric Lighting.—At last Monday's meeting of the Corporation, Mr. Robinson proposed the adoption of the Electric Lighting Committee's report in relation to the extension of plant. He said that though the contract was being given to Messrs. Fowler and Company, who were an English firm, it was agreed that the boilers and all other articles, so far as possible should be made in Dublin. The proposed extension of plant was rendered necessary by the spreading demand for electric light which they saw on all sides. Alderman Toole seconded the motion. Mr. Buckley asked to have the matter postponed until another report which there was on the subject was laid before them. He regretted that the contract should be given to an English firm. Mr. Robinson said that the engines which had been put in during the first installation by Messrs. Victor Coates & Company, Belfast, were said by their engineer to be defective in some important particulars, and the committee had adopted the report of their technical advisers. Alderman Pile submitted an amendment to the effect that the tender be referred back to the committee for further information, and in order to find out whether they could not get from any company an amended tender on a more satisfactory basis than the one now proposed. Mr. Clancy seconded the amendment. Mr. Robinson said that additional customers were being taken on every day in the anticipation that they would have the plant ready by September next, and if the matter was sent back to the committee now, nothing could be done to satisfy the new customers. Mr. Shanks said that if Mr. Robinson would say that Messrs. Fowler & Co., Messrs. Porte, Sykes & Co., and the other contractors were treated with equal fairness, all suspicion would be removed from his mind, and from the minds of many other gentlemen on this subject. Statements had been made as to favouritism, or what looked like it, being shown. Mr. Robinson said that a second tender was sent in by Messrs. Porte, Sykes & Co., which was considered and regarded as unsatisfactory by the committee, Messrs. Fowler sent in a second tender also, which was found satisfactory. Replying to Mr. Clancy, Mr. Robinson said that the committee subsequently entered into correspondence with Messrs. Fowler as to modifying their tender. Mr. Clancy said he thought cross-examination was necessary to get full information from Mr. Robinson. He believed that there had been correspondence with one firm to the detriment of another. Mr. Robinson said that the report of their engineer stated that Messrs. Porte, Sykes & Co.'s tender was unsatisfactory, and it was for that reason that the committee did not enter into negotiation with them. Mr. Clancy said he believed that more things were wrong with the electric department than the public had knowledge of. He thought that the Electric Committee ought to be amalgamated with the Lighting Committee, so that its doings might be participated in by a larger number of persons than was the case at present. Alderman Pile altered his amendment to read as follows:—"That the report be referred back to the committee for further information and comparison, and that all contractors who have already tendered get the same information and specifications as Messrs. Fowler & Co." Alderman Toole said the committee had obtained the very best advice they could, and they accepted the very best and cheapest contract possible. He thought it would be a mistake to pass this amendment. The Lord Mayor said that if they landed the Electric Light Committee in the morass now suggested by the adoption of this amendment he feared it would very much tend to prevent the extension of electrical lighting in Dublin. The committee had in no way exceeded their functions, and by adopting the amendment, he thought they would be risking the future of electric lighting in their city. No respectable contractor would in future have anything to say to them if they looked forward to being treated in this way. The amendment was lost by two votes, 18 voting for and 20 against it. On the motion of Mr. John Reilly, seconded by Mr. M'Auley, the report was referred back to the committee for further consideration, without any conditions being laid down.

The City Telephone Service.—The National Telephone Company for some time past have, with the view of giving an improved service, been engaged erecting new plant, and planning and making alterations necessary to introduce the twin wire or metallic circuit system into the City. The re-arrangement of the company's exchanges, rendered necessary by these improvements, makes it imperative that exchange numbers should be altered, and they have given notice of the proposed change, which they anticipate will be brought into operation in about six months time. A supplemental list of subscribers will be issued, notifying the change to all the subscribers on the company's metropolitan exchange system.

Price Lists, &c.—The Carboid Oil-less Bearing Company, Limited, have sent us one of their lists of Hedges's patent automatic-winding portable electric lamp standards which we recently described in these columns.

From Messrs. Ludwig Loewe & Co.'s London agent (Mr. H. F. L. Orcutt), we have received a nicely prepared price list of turret lathes, screw machines, &c. The articles described are well illustrated.

Messrs. Faraday & Son have sent us a list of their Crystal "Star" pendant. The list is, as usual, tastefully got up.

Stirling Electric Lighting.—Our notice of last week would convey the impression that the matter of the Provisional Order was settled. We, however, since learn that such is not the case. The Town Council have resolved to decline to withdraw their opposition to the order of the Caledonian Company, and resolved to request the Board of Trade to withhold their consent to the order on the ground that the company now refuse to grant to the Council the terms they had previously offered.

Coventry Electric Lighting.—Plans for the erection of the central station have been approved by the Electric Light Committee.

Medical Battery Company, Limited.—On Tuesday last, Mr. Warley, Deputy Official Receiver, presided at a meeting of the creditors of the Medical Battery Company, Limited, held at the Inns of Court Hotel, Holborn, for the purpose of considering a draft scheme of reconstruction put forward by the debenture holders, shareholders, and creditors of the company. At the opening of the proceedings it was ruled that the meeting should be private, and it was stated that the scheme would be made public when complete and approved.

Electric Lighting in Aberbeen.—Prof. Kennedy has engaged Mr. George G. Clark as second engineer in connection with the electric lighting station for the period of six months. The Gas Committee have authorised the purchase of 20 10-ampèremeters, 20 25-ampèremeters, and 10 50-ampèremeters, the estimated cost being £320.

Electric Light at Accrington.—A committee of the Corporation have recommended the Town Council to forthwith put down plant for furnishing the electric light, with steam as the motive power, and having an output equivalent to the supply of not less than 2,000 16-C.P., or 4,000 8-C.P. incandescent lamps, with provision for extension.

Electric Lighting of Swansea Docks.—Two dynamos, with which it is intended to light by electricity the ships building at the dockyard, have been ordered, and will be delivered shortly. The dynamos will also supply the electricity necessary for a new process of drilling which it is proposed to introduce.

Electric Light at Glasgow.—The Kelvinside Electricity Company have decided to reduce the price of electric supply after May 15th, to 6d. per Board of Trade unit. This is a reduction of 2d. on the present price, and is a penny less than Corporation consumers pay.

Douglas Electric Tramways. — The Douglas Bay Tramway Company have now decided to sell their undertaking to the Douglas and Laxey Electric Tramway Company for £34,000. A new company is being formed, amalgamating the two concerns, to run from Victoria Pier, Douglas, to Laxey, a distance of eight miles.

The Electric Lighting of Dewsbury Workhouse.—The guardians have decided to erect the necessary buildings and plant for lighting the workhouse, and cottage homes belonging to the union, by electricity, and to ask for powers to borrow £2,150 towards the cost.

Electric Lighting of Liverpool Street Station.—In addition to the enormous extensions which are being carried out at this station, an important electric light installation has been laid down, the contractors for the plant being Messrs. Davey, Paxman and Co., and Messrs. Crompton & Co., Limited.

Anti-Sulphuric Enamel.—This material has been used in the accumulator rooms of the Carnaby Street electric light station of the St. James's and Pall Mall Electric Light Company to protect the wood and metal-work from the action of the acid fumes and spray thrown off by the batteries.

Country House Lighting.—The lighting of Mr. Heath Harrison's country house at Le Court has been entrusted to Messrs. Drake & Gorham. The engine is of the semi-portable type, and the dynamo one of the Electric Construction Company's make.

York and Electric Lighting.—At the monthly meeting of the York City Council a sub-committee was appointed to inspect the electric lighting plant and installations at Oxford laid down by the Electric Construction Company.

Dover Electric Lighting. — Arrangements have been made for laying the mains which will be necessary for supplying public and private lights in Dover. The Sea Front section of the work is being put in hand first.

Personal.—Mr. A. B. Blackburn, M.I.C.E. (late with Messrs. Mather & Platt, Limited), has been appointed chief engineer of the Electric Construction Company, Limited.

Ship Lighting.—The British India Steam Navigation Company's new steamship, *Dwarka*, is lit throughout with the electric light, there being in all 178 incandescent lamps.

CONTRACTS OPEN AND CLOSED.

OPEN.

Edinburgh.—April 11th. For works required in the erection of the buildings, &c., of the central electric lighting station at Torphichen Street, consisting of engine house, battery, and store rooms, boiler house, chimney shaft, staircases, offices, water tanks, cellarage, &c., and other relative works, for the magistrates and Council.

Rhyl.—Tenders wanted for lighting the pier and pavilion by electricity.

CLOSED.

Blackpool.—The following are the tenders sent in for electric lighting the United Methodist Free Church, in Adelaide Street:—Maunsell Mercier & Co., £70; Briscoe & Shaw, £129; Scott and Mountain, Limited, £118; J. McLellan, £105; F. Stewart, £98 11s. 6d.; Corlett Electric Engineering Company, £95; Fowler, Lancaster & Co., Limited, £87 10s.; W. J. Proctor, £87 9s. 6d.; Paterson and Cooper, £87; E. Dewhurst, £79 15s.; Dennison & Parmiter, £77 10s.; T. H. Churton, £75; B. Verity & Sons, £70 12s. Note—These tenders include electroliers. Edison & Swan Company, Manchester, £57 10s.; Bowker, Bros., £53; Crabtree & Harrison, £53; W. Banks and Co., £45; J. Berry, £42 12s. 6d.; Furnis, Paterson & Co., £38; Baxendale & Co., £55. Note—These tenders do not include electroliers.

Belfast. — Messrs. Penman & Co., of Glasgow, have secured the contract for the Cornish boiler required for the Belfast electric lighting.

FORTHCOMING EVENTS.

Friday, April 6th.—Institution of Electrical Engineers. Studen meeting at 8 p.m., at 28, Victoria Street, S.W. Paper to be read by Mr. A. F. Berry on "Notes on Alternate Current Transformers." Mr. W. M. Mordey will take the chair.

Monday, April 9th.—Northern Society of Electrical Engineers. Discussion on "Notes on Designing a System of Underground Electric Light Mains," by Mr. John H. Rider, and "The Various Systems of Underground Mains and Methods of Laying Same," by Mr. S. V. Clirehugh, will be continued. A paper on "Electricity Meters" will be read by Mr. R. P. Wilson.

Monday, April 9th.—Society of Arts, at 8 p.m. Second Cantor lecture on "Photometry," by Capt. W. De W. Abney, C.B., F.R.S. Points to be dealt with:—Principles of measurement; different methods of photometry; oscillation and scintillation in light measurement; colour no bar to measurement.

Tuesday April, 10th.—Institution of Civil Engineers, at 8 p.m. Paper by Mr. Charles Hunt, on the "Construction of Gas Works."

Tuesday, April 10th.—Royal Institution, at 3 p.m. Second lecture on "Electric Illumination," by Prof. Fleming.

Tuesday, April 10th.—Royal Meteorological Society's fourteenth exhibition, to be held in the rooms of the Institution of Civil Engineers, 25, Great George Street, Westminster. The exhibition remains open until 20th inst.

Thursday, April 12th.—The Institution of Electrical Engineers. Meeting at the Institution of Civil Engineers, 25, Great George Street, S.W., at 8 p.m. Discussion on "The Best Resistance for the Receiving Instrument with a Leaky Telegraph Line," by Professor W. E. Ayrton, F.R.S., past president, and C. S. Whitehead, M.A. Papers to be read on (1) "Transparent Conducting Screens for Electric and Other Apparatus"; (2) "An Astatic Station Voltmeter," by Professor W. E. Ayrton, F.R.S., past president, and T. Mather, Associate. Paper on "Cost of Electrical Energy," By R. E. Crompton, M.Inst.C.E., vice-president.

Friday, April 13th.—Physical Society, at 8 p.m. Paper by Dr. C. V. Burton, on the "Mechanism of Electrical Conduction."

Friday April, 13th.—Royal Institution, at 9 p.m. Prof. J. J. Thomson, F.R.S., on "Electric Discharge through Gases."

BOOKS RECEIVED.

Transactions of the American Institute of Electrical Engineers. Vol X. Published at the Institute, New York.

Reference Book of Tables and Formulæ for Electric Street Railway Engineers. By E. A. Merrill. Published by the W. J. Johnston Company, Limited, New York.

NOTES.

Appointment.—Mr. C. H. Wordingham is to be congratulated upon his appointment as resident electrical engineer at the Manchester central station. The salary is £500 per annum. Some of the members of the council are of opinion that the position should have been open to public competition, which it was not, the appointment being recommended by Dr. Hopkinson and the Electric Lighting Sub-committee.

The London Telegraph Service.—The Post Office officials are making arrangements to draft over 200 clerks from the provinces to the Central Telegraph Office, to prevent overtime being worked as much as possible this season.

Chatham and Electric Tramways.—At a meeting of the Town Council last week, it was resolved "That the cost be ascertained of constructing a tramway from the Luton Arch to the top of Star Hill to be driven by electricity, and that should the council decide to construct such tramway, the Chatham Electric Lighting Company be asked whether they would be prepared to contract with the corporation to supply the current, and the probable cost."

Lectures.—Before the Sheffield Junior Engineering Society last week, Prof. W. H. Watkinson, of the Glasgow and West of Scotland Technical Institute, read a paper on "Gas *v.* Steam Engines for Factories and Electric Lighting Stations."

At the Plymouth Athenæum last week, Mr. W. A. Rudge was to have delivered a lecture on "Modern Ideas of Electricity," but was prevented from doing so owing to illness.

A lecture on "Electrical Forging and Welding," was delivered on Saturday last before the Sheffield Society of Engineers, by Mr. T. Scott Anderson, A.M.I.E.E.

Exhibition.—The Royal Metereological Society's fourteenth exhibition of instruments, which will open on Tuesday next, April 10th, in the rooms of the Institution of Civil Engineers, 25, Great George Street, Westminster, will be devoted mostly to instruments, drawings, and photographs relating to the representation and measurement of clouds. The exhibition promises to be a very interesting one, and will include original cloud sketches by the late Luke Howard, F.R.S., as well as photographs of clouds by the highest authorities in various parts of the world. The exhibition will remain open till the 20th inst.

Central London Railway—The Standing Orders Committee of the House of Commons met on Tuesday to consider a report from the examiners to the effect that the Central London Railway Company had failed to comply with the Standing Orders in respect of their petition for leave to introduce a Bill to extend the time within which to construct this railway. The proceedings of the Committee were conducted in private, but it was announced that the Committee had decided to dispense with the Standing Orders not complied with. In the event of this Bill being sanctioned, the time for completing the line will be extended until June 28th, 1900.

New Zealand Tramways.—The City and Suburban Tramway Company, of Dunedin, have for some time been desirous of introducing electricity into their system, but, for some reason or other unknown to us, the proposal has met with opposition from the Government. Last year the loss on the working of the line was £300, and this the directors attribute to their having to employ horses. They anticipate no better result until the horses have been supplanted by electric traction, and the chairman at the last meeting cheerfully remarked that there were signs that the Government was giving way somewhat in the opposition to the introduction of electricity. We shall be glad to hear before very long that the horses have completed their last journey on the line, and electricity takes over their duties.

Hermite's Electrolytic Sanitation.—The Worthing correspondent of the *Daily Chronicle* states that an unfavourable report upon the results of the trial of M. Hermite's system of treating sewage matter with electrolysed sea-water has been prepared by Dr. C. Kelly, medical officer of health of the borough and of the combined sanitary district of West Sussex. The report is of a most elaborate nature, and contains the results of chemical and bacteriological analyses made respectively by Dr. Dupré, of Westminster, and Dr. Kein, of St. Bartholomew's Hospital. Dr. Kelly says he has not gone into the question of cost, but he points out that besides the annual cost of producing sufficient electrolysed fluid there would be a very great outlay in putting down a fresh set of mains, pipes and cisterns, so as to convey it to each house. The results of the various tests are set out in detail, and Dr. Kelly concludes:—"Since there is no instantaneous decomposition of fæcal matter and no sterilisation of sewage, I am of opinion that the process, as far as the late trials have gone, has therefore failed to produce the results which are claimed for it by its inventor."

Electric Light v. Gas.—Enquiries were recently made regarding the cost of lighting certain parts of Woodilee Asylum by gas or electricity for the Barony Parochial Board, Glasgow. In the estimates presented, the initial cost of electric lighting was £562, against £440 for gas, and the annual cost at £98, as against £92 for gas. Upon these estimates being submitted, it was decided to light the asylum by gas.

Aurora Borealis and the Telegraph Wires.—Mr. W. H. Preece has written the following letter to the *Times*:—"There was an extremely brilliant display of aurora between 10 and 10.45 p.m. on Friday, the 30th ult. It was accompanied, as usual, by very strong earth currents on all telegraph lines. But at 10.20 p.m., when all the telegraph circuits were idle, a peculiar frizzling and bubbling noise was heard upon a telephone inserted upon a long Irish wire at Llanfairpwll in Anglesey. At 2 a.m. on Saturday, the 31st ult., "twangs" were heard, as if a stretched wire had been struck. These were followed by a kind of whistling sound. Were these signals from space, or mere disturbances of atmospheric electricity?"

New Journal.—*Elektron* is the title of a new American monthly magazine, published in Boston, and devoted to electricity and its allied interests "in their scientific and practical aspects." Among the contributors are some well-known American electrical writers. There are such a host of electrical magazines and journals in America, that one is tempted to wonder where they all circulate. We should hardly think there is scope for this new venture; however, in wishing the proprietor success, we would recommend him to make some effort to remove, in future issues, the awkwardness and monotony of the first number; at present, there is little attractiveness either in the articles or in the general style of the publication.

The Antwerp Exhibition.—A meeting of the Consultative Committee in connection with the Antwerp Exhibition Committee was held at the London Chamber of Commerce on Wednesday, Sir Albert K. Rollit, M.P., presiding. The chairman said he had received information from Her Majesty's Consul-General for Belgium that the whole of the space originally allotted to him for Great Britain had been taken, and he had been compelled to apply for a supplementary allotment in order to meet further demands for space. Part of the central avenue adjoining the British section had also been occupied by British exhibitors, but this would not suffice, as applications for space were being received almost daily. The Indian Government had also secured an allotment of space. The opening of the Exhibition would take place on Saturday, May 5th, when the King would perform the ceremony.

The Rating of Electric Lighting Undertakings.—The financial progress which so many companies are making is beginning to excite the attention and cupidity of the rating authorities, with the result that assessments, in some instances of a most unreasonable character, are attempted to be put into force. We have previously had to direct the attention of our readers to this matter, and some further illustrations of the process have come to our notice. The Eastbourne authorities some time ago raised the assessment of the Eastbourne Electric Light Company from £150 to £795. No doubt some increase in the assessment was warranted by the progress the company had made, but Mr. Humphreys-Davies, of the Machinery Users' Association, advised that the large increase was altogether unjustifiable. The result of the appeal has been a reduction to £525, or about two-thirds. In another case, also conducted by the same Association, the Preston authorities have now offered to reduce the assessment of the National Electric Supply Company, Limited, from £1,095 to £675, but this offer has been declined, and an appeal to Quarter Sessions is intended. As Preston is one of the most highly rated towns in England, the aggregate rates amounting to nearly 8s. in the pound, the importance of the question will be easily seen, for, as the rates are the first charge upon the undertaking, each increase of £100 in the assessment practically means adding £1,000 to the debenture debt if the latter can be raised at 4 per cent., or £800 if at 5 per cent.

The Kingswood Electric Tramway.—There is to be a little opposition to the scheme for laying an electric tramway from St. George and Kingswood. The general feeling, however, is with the promoters, and it is expected that the opposition will have little effect.

Patent Law in Denmark.—We are informed that on the 28th ult. a new Patent Law for Denmark passed both Chambers of the Legislature, and it is expected will be signed by the King in the course of a few days. The principal features are the same as the laws of Germany, Norway and Sweden, viz.:—Protection from date of filing application; duration of patent, 15 years; importation of patented articles prohibited; examination as to novelty prior to the grant; opposition to grant by interested party permitted. The new law is to come into operation about the middle of June, and it would be well for anyone contemplating patenting an invention in Denmark to wait until then before having an application for Letters Patent filed, and thus obtain the advantages of the new law.

The Influence of High Tension Electricity on the Formation of Amalgams.—The *Berichte* contains an interesting communication from G. Staats on the manufacture of amalgams or mercury alloys, under the influence of high tension electricity. The electricity was supplied, in the experiments undertaken, from a Leyden jar, covered on the outside with tinfoil, and containing mercury to the same height as the outer covering, and having a steel wire terminating in a small silver disc. This formed the means of connection between the charging knot and the mercury in the interior, and the weight of this disc was determined both before and after the experiments. In a second series of experiments the steel wire and disc were exposed to a stream of sparks from the conductor of an influence machine for one minute, and then dipped in mercury for a few seconds, and weighed after its removal. These operations showed that whereas 23·07 per cent. of amalgam was formed without the use of electricity, 72·09 per cent. was produced when electricity was used as an adjunct. It would be even more interesting to see whether the use of high tension electricity would facilitate the formation of more commercially useful substances than the amalgams.

The Copenhagen-Stockholm Telephone.—The telephonic connection between Copenhagen and Stockholm, which was opened to the public on December 5th last year, has a length of about 400 statute miles, and consists of the following sections:—

	Miles.
Underground wires in Copenhagen	1·32
Overground wires to Vedbœk	13·67
Submarine cable from Vedbœk to the Island of Hveen	5·91
Submarine cable from Hveen to Hillesborg (near Malmö, Sweden)	4·42
Overground wires from Hillesborg (Malmö) to Stockholm	372·84
Total	398·16

On the Danish side the wire is phosphor bronze, 3 mm. in diameter, with a resistance of 4·19 ohms per statute mile at 60° F. On the Swedish side hard drawn copper wire (3 mm.) is used, with a conductivity of 95 per cent., and a resistance of about 4 ohms per mile. Both these sections consist of double wires, erected on the twist principle, and two opposite cores in the cable across the Sound (from Vedbœk to Hillesborg, near Malmö) are joined up in the telephonic circuit. The articulation is distinct and clear, but it has been improved somewhat by inserting an electro-magnetic shunt between the two cores of the submarine cable at the landing place on the Island of Hveen. The resistance of this shunt, which is wound on an iron core, is about 2,000 ohms, and it seems to produce sufficient self-induction to counteract the electrostatic capacity of the cable, and helps perhaps also as an artificial leak. The instruments in use are an improved pattern of Ericsson's apparatus, with a special kind of microphonic transmitter. The tariff is 2 krover (*i.e.*, 2s. 3d.) for a conversation of three minutes' duration. The number of daily conversations between the two capitals is at present rather limited, but there seems to be a prospect of a gradual increase.

NEW COMPANIES REGISTERED.

Altrincham Electric Supply, Company, Limited (40,795).—This company was registered on the 22nd inst. with a capital of £50,000 in £1 shares, to take a transfer from the Manchester Edison-Swan Company, Limited, of a provisional order granted to them by the Board of Trade, and confirmed by the Electric Lighting Orders Confirmation, No. 4, Act, 1893, authorising the undertakers to deal with electricity in various ways within the Local Board district of Altrincham, in the Parish of Bowdon, to adopt a certain agreement, and to carry on the business of electrical engineers, and suppliers and generators of electricity. The subscribers (with one share each), are: W. J. Crossley, Altrincham, Cheshire, engineer; C. C. Dunkerley, Dunham Massey, Cheshire, merchant; W. P. J. Fawcus, Portenscale, Hale, Cheshire, engineer; H. T. Gaddum, Bowdon, merchant; W. O'Hanlon, Bowdon, merchant; W. Warburton, Bowdon, solicitor; W. A. Arnold, 5, Cross Street, Manchester, stockbroker. The first directors are, W. J. Crossley, C. C. Dunkerley, Wm. Paul, James Fawcus, H. T. Gaddum, Wm. O'Hanlon, and E. J. Sidebothom; qualification, £200; remuneration to be decided in general meeting. Registered office, Temple Chambers, 33, Brazennose Street, Manchester.

Electric Traction Company, Limited (40,798).—This company was registered on the 22nd inst. with a capital of £300,000 in 29,880 £10 ordinary shares and 1,200 £1 deferred shares, to enter into contracts for the construction, repair and maintenance of, and to construct, equip, repair and maintain, under contract, or as owners, any works whatever, including, among others, railways and other roads or ways to be used for traction by electricity, steam, or any other agency, and, among other things, to lay systems of telephonic communication or electric lighting. The subscribers (with one share each) are:—E. T. Botwright, 115, Osborne Road, E., accountant; F. P. Shuckard, 233, New Cross Road, S.E., accountant; W. H. Adams, 168, Friern Road, East Dulwich, accountant; H. D. Brooke, 159, Wray Crescent, N., solicitor; W. B. Butler, 26, St. Stephen's Road, W., secretary; W. J. Yeoman, 23, Muschamp Road, S.E., solicitor's clerk; G. Dewdney, "Heavitree," Hendon, N.W., solicitor's managing clerk. There are not to be less than three nor more than seven directors. Qualification, £1,000; remuneration not yet determined. Registered by Ashurst, Morris, Crisp & Co., 17, Throgmorton Avenue, E.C.

London Refuse Steam Generator and Electrical Power Corporation, Limited (40,732).—This company was registered on the 16th inst. with a capital of £600,000 in £1 shares, to enter into a certain agreement made with the Atlas Contracting Syndicate, Limited, to carry on in England, or elsewhere, the business of engineers, boiler makers, electricians, electrical contractors and suppliers of electricity for the purposes of heat, light, sound, power, or otherwise, and to acquire patents, secret processes, and the like. The subscribers (with one share each) are:—W. Cooper, 31, Lombard Street, E.C., secretary; F. J. Baker, 2, Bawtree Road, S.E., secretary; T. H. Lambert, 44, Buckingham Palace Mansions, S.W., director of a public company; C. Brown, 91, Halton Road, N., accountant; M. Silliton, 2, Great Ormond Street, W.C., gentleman; F. C. Austen, 31, Waller Road, S.E., accountant; H. E. McCurdle, Stoke Newington, N., clerk. The number of directors is not to exceed ten. Qualification, 200 shares; remuneration, £250 per annum each, with certain additions. The chairman is to receive £150 per annum, extra. Registered by Jordan & Sons, 120, Chancery Lane, W.C. Registered office, 18, Eldon Street, E.C.

Rowland Barnett & Co., Limited (40,774).—This company was registered on the 20th inst. with a capital of £20,000 in £1 shares, to acquire the business of an electrical and mechanical engineer, carried on by R. H. Barnett, at Newcastle; to enter into a certain agreement and to carry on business as an electric light company, electricians, and all kindred trades. The subscribers (with one share each) are: R. H. Barnett, 21, Brighton Grove, Newcastle, engineer; H. A. Westmacott, Newcastle, engineer; C. Woods, Benton Hall, Newcastle, gentleman; F. R. Fenwicke, Harbottle Castle, Northumberland, agent; C. Liddell, Hexham, coal owner; J. Cooper, Newcastle, secretary; A. W. Dixon, Gateshead-on-Tyne, engineer. The number of directors is not to be less than three nor more than seven. The first

are R. H. Barnett and H. A. Westmacott; qualification, £100; remuneration, £20 per annum, divisible. Registered office, 8, Mosley Street, Newcastle.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Eston Arc Lamp Syndicate, Limited.—The solicitors of this company (Messrs. White & De Buriatte) state that this company never went to allotment, and that no business of any kind has been done.

Taunton Electric Lighting Company, Limited.—According to a document lately filed at Somerset House, this company has been wound up voluntarily, and Messrs. Albert Goodman and Wm. James, both of Taunton, have been appointed liquidators.

Westminster Electric Supply Corporation, Limited.—This company's last annual return, filed on the 14th inst., shows that, out of a nominal capital of £300,000, in £5 shares, the whole of the shares have been taken up, and the full amount duly paid.

Laurence, Scott & Company, Limited.—The last annual return of this company shows that out of a nominal capital of £30,000, in £10 shares, 1,406 shares have been taken up, 906 of which have been fully-paid. A sum of £5,000 has been agreed to be considered as fully-paid.

Woolwich District Electric Light Company, Limited.—This company filed its last yearly return on the 13th inst. It shows that out of a nominal capital of £10,000, in £1 shares, 5,435 shares have been taken up, and that £1 has been called and paid on each of 5,285 shares. A sum of £150 has been agreed to be considered as paid.

Electrolytic Caustic Soda and Chlorine Trust Company, Limited.—This company's annual return shows that out of a nominal capital of £20,000, in £10 shares, 1,500 shares have been taken up, and that the full amount has been called on 750 shares, and £6 on each of 250 shares. A sum of £9,000 has been received in response to calls, and £5,000 has been agreed to be considered as paid.

Northampton Electric Light and Power Company, Limited.—This company's last return was filed on the 14th inst., and shows that out of a nominal capital of £50,000, in 10 "A" and 49,990 "B" shares, all of £1 each, 10,000 "B" ordinary and 3,200 "B" preference shares have been taken up, and that £1 has been called upon each. The sum received is £13,200.

Newcastle-upon-Tyne Electric Supply Company, Limited.—This company's latest yearly return was filed on the 17th ult., and shows that out of a nominal capital of £50,000, in £5 shares, 6,769 shares have been taken up. A sum of £4 has been called on 6,701; £28,735 has been received in response to calls; and £340 has been agreed to be considered as paid.

Orient Electric Light Company, Limited.—This company, says a document filed at Somerset House on the 9th ult., has been wound up voluntarily, under the provisions of the Companies' Acts, 1862 to 1890, and Mr. Robert Wolfenden, of 43, Finsbury Square, E.C., solicitor, has been appointed liquidator.

Newcastle and District Electric Lighting Company, Limited.—This company filed its yearly return on the 3rd inst. It shows that out of a nominal capital of £50,000, in £10 shares, 3,535 shares, with £8 called on each, and 1,031 shares, with £6 called on each, have been taken up. A sum of £34,226 has been received, and there is £240 outstanding.

Elmore's Patent Copper-Depositing Company, Limited.—The annual return of this company shows that out of a nominal capital of £200,000, in 91,195 ordinary and 8,805 preference shares, all of £2 each, the whole of the ordinary and 8,610 of the preference shares have been taken up. The full amount has been called on 67,895 ordinary and 8,610 preference shares; £152,577 10s. has been received, £46,600 has been agreed to be considered as paid, £440 is outstanding, and £7 10s. has been forfeited on 15 shares.

CITY NOTES.

Hove Electric Lighting Company, Limited.

We referred to this company's account in our issue of the 16th ult.; we are now able to give the analysis of the cost of production. It should be pointed out that the statement covers the whole period since the formation of the company in August, 1892, to the end of last year.

	1891.	1892.	1893.
Total capital invested	—	—	£21,700
Number of units sold	—	—	49,170
Number of lamps connected ...	—	—	6,915
Revenue from sale of current...	—	—	£1,375
Average price obtained per unit	—	—	6·7d.

Cost of production.	£		Per unit.
Coal	314		1·53d.
Oil, waste, water and engine room stores	50		·24d.
Salaries and wages at generating station	357		1·74d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	125	Works cost 4·12d.	·61d.
Rates and taxes	124		·60d.
Management expenses, director's remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	432		2·10d.
Depreciation of buildings and plant account	—		—
Renewal fund account	—		—
Total	£1,402		6·8d.

Revenue.			Average price obtained per unit.
By sale of current	1,375 0 0		—
Meter rents	67 0 0		6·7d.
Sale of lamps	—		—
Total	£1,442 0 0		6·7d.

Total cost per unit, 6·8d.; works cost, 4·12d.

The Borough of Kingston-upon-Hull Accounts.

The accounts and analysis of the Borough of Kingston-upon-Hull are as follows. This, we believe, is the first completed twelve months' accounts.

	1891.	1892.	1893.
Total capital invested	—	—	£32,818
Number of units sold	—	—	74,600
Number of lamps connected ...	—	—	—
Revenue from sale of current...	—	—	2,111
Average price obtained per unit	—	—	7·1d.

Cost of Production.	£		Per unit.
Coal	432		1·38d.
Oil, waste, water, and engine room stores	67		·21d.
Salaries and wages at generating station	342		1·1d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	53	Works cost 2·87d.	·17d.
Rates and taxes	135		·43d
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	552		1·78d.
Depreciation of buildings and plant account	—		—
Renewal fund account	—		—
Total	£1,581		5·08d.

Revenue.			Average price obtained per unit.
By sale of current	2,211 0 0		—
Meter rents	41 0 0		7·1d.
Sale of lamps	—		—
Total	£2,252 0 0		7·1d.

Total cost per unit (exclusive of depreciation and renewal accounts), 5·08d.; works cost, 2·87d.

Southampton Electric Light and Power Company, Limited.

There has been apparently a steady progress in the business of this company during the past 12 months. The number of units sold during last year number 53,848, as against 35,537, the lamp connection at the end of 1893 being 3,162, against 2,200 at the end of 1892. Equally satisfactory is the fact that though there is an increased revenue of £553, the expenses have remained about the same as they were in 1892. The sales of current during January and February of this year show such an increase compared with the same period last year that the directors are sanguine enough to anticipate a dividend at the next meeting.

	1891.	1892.	1893.
Total capital invested	—	—	£4,885
Number of units sold	—	—	53,848
Number of lamps connected ...	—	—	3,162
Revenue from sale of current ...	—	—	£1,585
Average price obtained per unit..	—	—	6·8d.

Cost of production.	£	Per unit.
Coal	272	1·21d.
Oil, waste, water and engine room stores	54	·24d.
Salaries and wages at generating station	376	1·67d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	49 (Works cost 3·3)	·21d.
Rates and taxes	80	·34d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	123	·54d.
Depreciation of buildings and plant account	150	·66d.
Renewal fund account	—	—
Total	1,120	4·87d.

Revenue.		Average price obtained per unit.
By sale of current	1,543 0 0	—
Meter Rents	42 0 0	6·8d.
Sale of Lamps	—	—
Total	1,585 0 0	6·8d.

Total cost per unit (exclusive of depreciation and renewal accounts), 4·87d.; works cost, 3·33d.

More New Companies.

The new issues which we have to refer to this week are those of the Altrincham Electric Supply Company, and the International Electric Storage, Limited.

The Altrincham Electric Supply, Limited, has been formed to undertake the electric lighting of public and private buildings in Altrincham, Bowdon, Dunham, and other neighbouring districts. The share capital is £50,000, in £1 shares, of which £25,000 are to be issued at present.

The International Electric Storage Company has been formed to purchase and work the British rights in Messrs. Theryc and Oblasser's accumulators. The share capital is £200,000, divided into 40,000 shares of £5 each, of which 9,000 shares will be allotted to the vendors and patentees; the first issue is to be of £150,000.

The prospectus commences with a rather meaningless extract from a contemporary as to the new electric locomotives which the Paris-Lyons Company is building, but further on we learn that the batteries are to operate these new locomotives. If these batteries are all they are claimed to be, the real sphere of usefulness will, for the present at any rate, be mainly in the direction of tramway traction. In all respects the statements put forward in the prospectus are couched in moderate language. The construction of the battery is no doubt known to many of our readers, but we may at a subsequent date, after testing it, say something more about it, and, we trust, favourably. An exceedingly strong board of directors has been got together. They are as follows:—S. Flood Page (deputy-chairman Edison-Swan United Electric Lighting Company, Limited), chairman; Vaughan Cousins (late H.M. Registrar-General, Singapore); J. L. Higgs (director Universal Electric Lighting Company, Limited); J. H. Mace (director London Road Car Company, Limited, and Northampton Streets Tramways); M. Ch. Theryc (director La Compagnie Française de l'Afrique Occidentale); B. H. Van Tromp (chairman Metropolitan Continental Tramway Company, Limited, and director of the Brush Electrical Engineering Company, Limited); Ernest Villiers (chairman The Mint, Birmingham, and director Edison-Swan United Electric Lighting Company, Limited). The consulting engineer of the company is Prof. Fleming; the engineer, Mr. Schanschieff.

Edison Gower-Bell Telephone Company, Limited.

The general meeting of this company was held on Thursday, 29th inst., at New Broad Street.

Sir Alexander Armstrong, who presided, moved the adoption of the report and accounts. The directors did not anticipate any return of capital on the 1,000 ordinary shares in the Telephone Company of Austria, that concern having been placed in liquidation. An early decision was expected in the action against infringers of the patent in Belgium, the case being now before the Court of Appeal at Liége. With regard to the sum of £393,611 appearing in the accounts as expenditure on patent rights, concessions and exchanges, those relating to the Portuguese properties were represented by 37,400 fully-paid shares of £1 each in the Anglo-Portuguese Telephone Company, while similar rights in Austro-Hungary were represented by the 1,000 fully-paid ordinary shares of £5 each in the Austrian company already alluded to. There were no directors' fees, and the expenses of management had been kept down to £230 14s. Dividends for two years, amounting to £2,000, had been paid on the 20,000 preference shares issued to the Consolidated Telephone Construction Company, and the dividend received as dividend on Anglo-Portuguese shares, less income-tax, £1,823 5s. The reserve stood at £2,293. The motion of adoption was seconded and agreed to.

Telephone Company of Egypt, Limited.

The ordinary general meeting of this company was held last Tuesday at the offices, Austinfriars.

General Alexander Fraser, C.B., who presided, stated that their business was going on satisfactorily. The arrangements connected with the management and control of the business in Egypt, to which reference was made in their last report, had involved an increase in the expenses, which, with the considerable outlay incurred at Alexandria, Cairo, and Port Said for reconstruction, had been charged against the revenue. He concluded by moving the adoption of the report.

Mr. Henry Grewing seconded the motion, which was carried.

Eastern Extension, Australasia and China Telegraph Company.—The accounts of the Eastern Extension, Australasia and China Telegraph Company to December 31st show, subject to audit, a balance of profit of £189,080 after payment of three interim dividends. The directors propose to distribute the usual dividend of 2s. 6d. per share, making a total dividend of 5 per cent. for 1893, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year.

The Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 2s. per share, free of income tax, being at the rate of 2 per cent. per annum, for the quarter ending March 31st, 1894, such dividend to be payable on and after the 24th inst.

W. T. Henley's Telegraph Works Company.—Warrants have been posted to the shareholders of this company for dividends at the rate of 7 per cent. per annum on the preference shares (less income tax) for the half-year ending December 31st, 1893, and 5 per cent. per annum on the ordinary shares (free of income tax) for the year ending December 31st, 1893.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending April 1st, 1894, amounted to £844; week ending April 2nd, 1893, £744; increase, £100: total receipts for half-year, 1894, £12,035; corresponding period, 1893, £12,015; increase, £20.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of March were £4,200; as compared with £4,275 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of March, 1894, amounted to £1,800, against £2,015 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in March, 1894, were £22,000; January 1st to March 31st, 1894, £63,000; corresponding months, 1893, £63,200; corresponding month, 1892, £62,800.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 30th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,659.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, March 28th.	Closing Quotation, April 4th.	Business done during week ended April 4th, 1894. Highest.	Lowest.
184,500/	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	100 —103	100 —103	...	...
1,134,640/	Anglo-American Teleg., Ltd.	Stock	£2 12s	£2 15s.	£2 11s.	42 — 44	42 — 44	44	...
2,932,680/	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s	£5 2s.	78½— 79½	79 — 80	82	79¼
2,932,680/	Do. do. Defd.	Stock	...	...	...	7¼— 7⅜	7⅛— 7⅜	8⅜	7 9/16
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½ % §	6½ % §	11⅜— 12¼	11¾— 12¼	12⅛	11 13/16
18,700/	Do. do. 5 % Bonds	100	...	...	...	99 —102	99 —102	...	...
75,000/	Do. do. 5 %, repayable June 1906	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	1½— 2½	1½— 2½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	146 —150	146 —150	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½ % §	2 % §	... §	1/16 — 1/16	1/16 — 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19	18 — 19	19	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	2½— 3½	2½— 3 xd	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	...	8½— 9½	8½— 9 xd	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	10½— 10¾	9¾— 10½	10⅜	9⅞
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	14⅜— 15	15 — 15½	15½	14⅞
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	16 — 16½	16 — 16½	16⅜	16¼
105,900/	Do. 5 % Debs., repay. August, 1899	100	...	...	...	107 —110	107 —110	105	104
1,294,100/	Do. 4 % Mort. Deb.	Stock	...	...	...	114 —117	114 —117	115½	114¼
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	15¼— 15½	15½— 15¾	15⅝	15¼
62,700/	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	...	...
222,800/	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000/	Do. 4 % Deb. Stock	Stock	...	...	...	113 —116	113 —116	...	...
95,100/	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	...	...
129,100/	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000/	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	104 —107	104 —107	...	...
200,000/	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5⅛% §§	4⅞% §§	4⅝% §§	8⅝— 8⅞	8⅜— 9	9	8⅜
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15 — 15¼	15⅛— 15⅜	15 5/16	15 3/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅗% §	8⅗% §	...	21½— 22	21¾— 22¼	21⅞	...
200,000/	Do. do. do. 5 % Debs.	100	...	...	...	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	43 — 45	43 — 45	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6	4 — 6	...	...
100,000/	Do. do. 6 % Debs.	100	...	...	...	106 —109	106 —109	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½— 1½	½— 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4½— 4¾	4⅝— 4⅞	4⅞	4⅝
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14½— 15½	14½— 15½	15⅜	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	14 — 15	14 15/16	14⅜
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅜— 5⅝	5⅜— 5⅝	5½	...
925,017/	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	115 —117	115 —117	117	115¼
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
220,000	Oriental Teleph., Ltd., 80,001 to 300,000; 11s. paid ...	1	2¼%	3⅜%	4¼%	... ...	... ...	...	...
100,000/	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5½— 6½	5½— 6⅞	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	113 —118	113 —118	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1½— 2	1⅝— 2	...	...
146,370/	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900/	Do. do. do. 5 % Debs.	100	...	...	...	98 —101	99 —102	101½	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2¼— 2⅜	2½— 3	2⅝	2⅝
150,000/	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	99 —103	101 —105	...	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	...	7⅜— 8¼	7½— 8	8	7 9/16
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6 — 6½	6 — 6½	6½	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	2 — 2½	2 — 2½	2⅛	...
178,200/	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	105 —108	105 —108	...	...
222,700/	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	105 —108	105 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	...	1½— 1⅝	1½— 1½	...	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10 — 10½	10¼— 10⅜	10⅝	10 3/16
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	8½— 9½	9 — 10	...	...
80,000/	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	106 —109	107 —110	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	113 —118	113 —118	...	...
169,000/	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4 — 5	4 — 5	...	...
40,000	Cityof London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	11½— 12½	11½— 12½	12½	...
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	13¼— 13⅜	13¼— 13⅜	13 7/16	13¼
19,900	*Electy. Supply Co. of Spain, 101 to 20,000...	5	...	...	...	... ...	... ...	...	...
30,000	†Liverpool Electric Supply, £4 10s. paid	5	...	...	...	5⅞— 6½	5½— 5⅝	5⅝	5⅜
15,000	Do. do.	5	4½%	5 %	5 %	6 7/16— 6 9/16	6⅛— 6⅜	6⅜	6½
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000	10	1 %	2 %	...	8¼— 8⅜	8 — 8½	8⅜	8¼
100,000/	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	106 —109	106 — 109	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½— 5½	4½— 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7½%	4½%	6½— 6¾	6½— 6¾	6¼	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 8½	8 — 8½	8⅜	8½
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	5⅜— 6¼	5⅜— 6¼	6	5 13/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ¶ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year, consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, March 28th.	Closing Quotation, April 4th.	Business done during week ended April 4th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅞ — 3⅛	3 — 3⅛	3 7/16	3
90,000	Do. do. Non-cum. 6 % Pref, 1 to 90,000	2	...	6 % §	6 % §	2⅛ — 2⅜	2⅛ — 2⅜	2 7/16	...
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	108 —111	108 —111	110½	109½
630,000/	City and South London Railway	Stock	...	8%	8%	27 — 32	27 — 32	...	...
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3½ — 4	3½ — 4	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	97 —102	95 —100 xd	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼ — ⅜	¼ — ⅜	½	7/16
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1⅛ — 2	1¼ — 1⅝	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼ — ⅜	¼ — ⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	⅜ — ½	⅜ — ½	...	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	⅜ — ½	⅜ — ½	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	¾ — 1⅛	¾ — 1⅛	...	...
12,134/	Greenwood & Batley, Ltd., Ord., 4,667 to 16,800	10	...	...	...	4⅛ — 5⅛	4⅛ — 5⅛	...	...
9,600/	Do. do 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23¾	23¼
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	101 —103 xd	101 —103 xd	...	...
11,334	International Okonite, Ltd., Ord, 22,667 to 34,000 ...	10	5 % §	...	...	1 — 2	1 — 2	.	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	6⅞ — 7⅛	5¼ — 5½xd	7	5
6,295	† Do. do. Pref., £8 paid	10	...	...	...	9⅛ — 9⅜	9 — 9¼xd	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	2 — 2⅛	2 — 2⅛	...	...
37,250	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	39 — 41	39 — 41	40¼	39½
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	.	...	... ...	... ...	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—5⅝.
Brush Company, 4½ % Debenture Stock, issued at 1 % premium, 106—108.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
Electricity Supply Corporation, Ordinary of £5, 5—5¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6¾.
Liverpool Electric Supply, £5 (fully paid), 6½—6⅞.
Do. do. £3 10s. paid, 4½—4⅞.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

A Universal Shunt Box for Galvanometers, by W. E. Ayrton, F.R.S., past-president, and T. Mather, Associate. (Read Thursday, March 29th, 1894.)

Several years ago Mr. Latimer Clark drew attention to the fact that when shunts were used with a ballistic galvanometer in the comparison of the capacities of condensers, the results were inaccurate if the multiplying powers of the shunts were assumed to be the same as those employed with steady currents; shortly afterwards the matter was investigated mathematically by the late Mr. Hockin, and he showed that the inaccuracy was caused by the change which the application of the shunt produced in the damping of the swing of the ballistic galvanometer. Hence the instantaneous deflection of a galvanometer when shunted showed an extra diminution, as if its resistance had been increased by an amount which depended on the details of the construction of the particular galvanometer, and on the adjustment of the controlling magnet.

In 1892, when giving a preliminary account of our "workshop ballistic galvanometers" at the Physical Society, we incidentally mentioned a method that we had devised of constructing shunts which entirely overcame this difficulty. At that time we had only perceived that our method of constructing *constant-damping* shunts was of value in connection with ballistic galvanometers; but subsequently it occurred to us, when specifying the resistance of such constant-damping shunts, that this method of construction not only removed the difficulty which had been pointed out by Mr. Latimer Clark in connection with ballistic galvanometers, but it enabled the same shunt box to be used with any number of different galvanometers of any resistance and of any type, and with an accuracy in the measurement far greater than could be obtained with the ordinary form of shunt box which had been specially constructed for the particular galvanometer.

As this method of making shunt boxes has not yet been published, and as it possesses important advantages of which we were not aware when we alluded to it at the Physical Society, we have thought that a short description of the method may interest the members of the Institution of Electrical Engineers.

To appreciate its advantages let us first consider the common, well-known method of constructing shunts, and the defects it possesses.

1. The resistances of the $\frac{1}{10}$th, $\frac{1}{100}$th, and $\frac{1}{1000}$th shunt must have exactly $\frac{1}{9}$th, $\frac{1}{99}$th, and $\frac{1}{999}$th of the resistance of the galvanometer; therefore, if the resistance of the galvanometer be 1,000 ohms, for example, the shunts must have 111·1, 11·11, and 1·111 ohms resistance; hence we must construct the $\frac{1}{1000}$th shunt accurately to the $\frac{1}{10000}$th of an ohm if we wish it to be correct to even $\frac{1}{10}$th per cent.

2. But the galvanometer is wound with copper wire: we are therefore at once met with the difficulty as to what wire we ought to employ in winding the shunts. If we use German silver, platinoid, manganin, or any substance of low temperature coefficient for the wires of the shunt coils, their resistances may be quite constant, but a rise of 10° C. in the temperature of both the shunts and of the galvanometer will make an error of 4 per cent. in the resistance of the former relatively to that of the latter.

If, on the other hand, we wind the shunts with copper wire, then, since the shunts are not inside the galvanometer case, it is very difficult to ensure, from the readings of the thermometers, that there is not a difference of some two or three degrees between the mean temperatures of the shunt box and of the galvanometer, so that the resistances of the shunts may easily be 1 per cent. wrong relatively to that of the galvanometer.

In fact, except in the rare case when the galvanometer as well as the shunts are wound with German silver, manganin, or other wire of low temperature coefficient, it is useless spending time making accurate adjustments of the resistances of the shunt coils as ordinarily constructed.

3. Even if the resistances of the shunts be exactly $\frac{1}{9}$th, $\frac{1}{99}$th, and $\frac{1}{999}$th of the galvanometer, they act as if they did not allow $\frac{1}{10}$th, $\frac{1}{100}$th, and $\frac{1}{1000}$th respectively of the charge in a condenser to pass through the galvanometer when used ballistically.

4. Lastly, for each galvanometer there is needed a separate set of shunts.

All these defects arise from the fact that the method hitherto adopted of varying the current through a galvanometer while the current in the main circuit remained the same, has consisted in varying the resistance of the shunt to the galvanometer. If, however, we leave the shunt to the galvanometer untouched, and, instead, vary the current through the galvanometer by varying the point of attachment of the main leads, we remove all these difficulties at once.

A shunt box constructed in this latter way is seen in fig. 1. The terminals, A and B, of the shunt box are permanently connected respectively with the terminals of the galvanometer, G, while the terminals, B and C, of the box are connected with the two main wires which lead the current up to, and away from, the galvanometer and shunt. The ends of a coil of *any* resistance, r, ohms are permanently connected as shown, and at points in this coil corresponding with

$\frac{r}{10}$ $\frac{r}{100}$ $\frac{r}{1,000}$ ohms permanent connections are made with the various blocks of the shunt box, as illustrated.

Then, whatever be the resistance of this coil, r, compared with the resistance of the galvanometer, g (either, or both, of which may therefore be unknown), it is easy to show that if G amperes be the current flowing round the galvanometer when a plug is placed into the hole marked d, it will be $\frac{G}{10}$, $\frac{G}{100}$, and $\frac{G}{1,000}$ amperes respectively, when the plug is put instead into the holes marked c, b, and a, respectively, provided that the current in the main circuit remains constant—the condition which is, of course, assumed to be true in

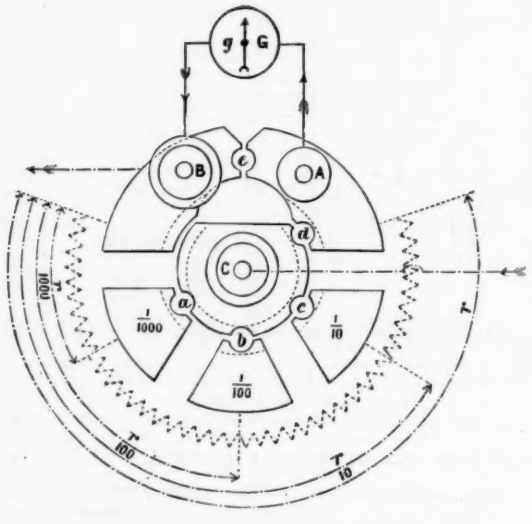


Fig. 1.

the ordinary use of shunts. Or, if a definite quantity of electricity flow into or out of a condenser in the main circuit, and Q coulombs be the quantity of electricity that flows round the galvanometer when the plug is in the hole, marked d, $\frac{Q}{10}$, $\frac{Q}{100}$, and $\frac{Q}{1,000}$ coulombs will be quantities that flow round the galvanometer when the plug is put into the holes, c, b, and a, respectively, and the deflections will correspond with these quantities.

For let the constant current in the main circuit be called A: then, when plug is in hole, d, the galvanometer current equals

$$\frac{r}{r+g}\ \text{A, say G;}$$

when plug is in hole c, the galvanometer current equals

$$\frac{\frac{r}{10}}{\frac{r}{10}+\left(\frac{9}{10}r+g\right)}\ \text{A, or}\ \frac{G}{10};$$

when plug is in hole, b, the galvanometer current equals

$$\frac{\frac{r}{100}}{\frac{r}{100}+\left(\frac{99}{100}r+g\right)}\ \text{A, or}\ \frac{G}{100};$$

when plug is in hole, a, the galvanometer current equals

$$\frac{\frac{r}{1,000}}{\frac{r}{1,000}+\left(\frac{999}{1,000}r+g\right)}\ \text{A, or}\ \frac{G}{1,000}.$$

Similarly, if K be the number of coulombs flowing into, or out of, a condenser in the main circuit, and $\frac{1}{10}$K, or Q, be the number of coulombs that flow round the galvanometer when the plug is put into the hole marked d, it may be proved that, *since the resistance of the galvanometer plus that of the shunt is constant, and, therefore, the damping is constant*, the quantities of electricity that will flow round the galvanometer when the plug is put instead into the holes marked c, b, a, respectively, are $\frac{Q}{10}$, $\frac{Q}{100}$, $\frac{Q}{1,000}$ coulombs.

Hence the galvanometer may be wound with copper or with any other wire; a single set of shunts may be made of manganin wire, and be accurately subdivided into *exact* numbers of ohms, *fractions of an ohm being unnecessary with our system;* the galvanometer may have any resistance and be at any temperature, provided it is constant while a set of tests is being made—then the sub-division of a steady current or the sub-division of an instantaneous rush of electricity into parts having the ratios of 1, $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1,000}$, is effected with *great accuracy.*

Stock shunt boxes, ready wound for use with any galvanometer, in the measurement of steady currents or of instantaneous rushes of electricity, are exhibited on the table.

The arrangement of shunt box illustrated in fig. 1 may be regarded as possessing one defect—viz., that the whole current flowing in the mains cannot be sent round the galvanometer without disconnecting the main wire from the terminal, C, and connecting it instead with the terminal, A. To save the trouble of having to do this, and to enable every combination to be made by simply shifting the plugs, we sometimes construct the blocks of the shunt box as seen in fig. 2.

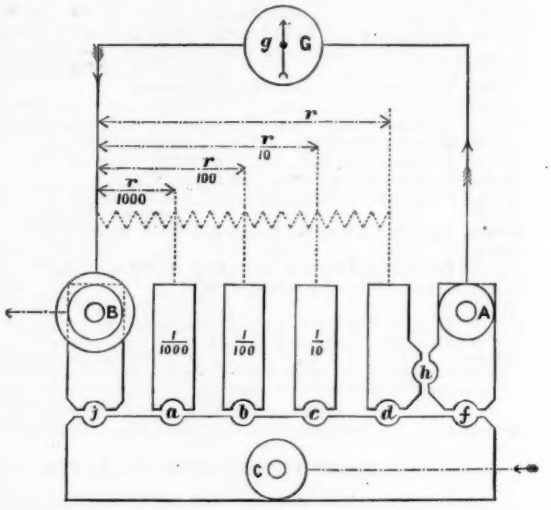


Fig 2.

When one plug is placed and left in the hole marked h, and a second plug is placed in one or other of the holes marked d, c, b, or a, we obtain exactly the results already described in connection with the box seen in fig. 1. Placing, however, one plug only in the hole marked f, the entire current flowing in the mains circulates round the galvanometer. If a plug be placed in the hole f, and another in the hole j, the galvanometer is short-circuited—a result obtained by placing the two plugs in the holes marked d and e in fig. 1. The arrangement shown in fig. 2 has the further advantage that it is possible, by putting a single plug into the hole marked j, to disconnect one terminal of the galvanometer from the circuit without breaking the circuit. This method of connecting is convenient to employ when taking the zero with a very sensitive galvanometer, for in that case it may happen that, although the galvanometer is apparently short-circuited through a very low resistance, enough of the main current, although but an extremely small fraction, passes round the galvanometer to produce a small deflection.

When, however, r is more than about ten times as great as g, the simpler form of shunt box illustrated in fig. 1 is sufficient for ordinary purposes; for, although by merely shifting the plug with this type of box, it is impossible to send a greater current round the galvanometer than $\frac{r}{r+g}$ A amperes, where A is the current in the mains, this value of G, being more than $\frac{10}{11}$ A, is sufficiently near A for ordinary purposes.

Of course, whatever be the value of r, whether large or small compared with that of g, the current that flows round the galvanometer when the plug is put into the poles marked c, b, and a, respectively, is exactly $\frac{1}{10}$th, $\frac{1}{100}$th, and $\frac{1}{1000}$th of its value when put into the hole marked d. The only advantage that is gained by making r large compared with g is that $\frac{r}{r+g}$ A, or G, the unit current, becomes then practically equal to A.

The method of using shunts above described has, then, the advantage that it enables the same shunt box to be used with any galvanometer of any resistance, whether ballistic or not; but it does more than that, for a consideration of our method of varying the point of attachment of one of the mains, instead of varying the resistance of the shunt itself, shows that *any ordinary* resistance box can be employed as a shunt with *any* galvanometer, and the fractions of the current that pass round the galvanometer and through the shunt respectively can be read off at once, *without any calculation and without a knowledge of the resistance of the galvanometer*, to a far higher degree of accuracy than is possible with a set of shunts specially constructed for the particular galvanometer in the ordinary way.

By employing this device we also find that great simplification and cheapening of cost is effected in the employment of a d'Arsonval galvanometer with shunts of platinoid or manganin sheet for the measurement of electric currents over a wide range.

It is well known that with the ordinary method of constructing shunts the resistance of the circuit is altered when the shunt is varied. An interesting question therefore arises whether this change in the resistance of the circuit is greater with the method that we have proposed of constructing a shunt box or with the ordinary method.

With the ordinary method of keeping the main leads, M_1, M_2 (fig. 3), permanently connected with the galvanometer, G, and of varying the current through the galvanometer by altering the resistance, s, of the shunt, the change that is produced in the resistance of the circuit

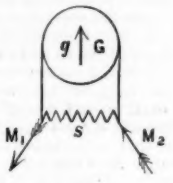


Fig. 3.

on applying this shunt is, as well known, *from* g to $\frac{s\,g}{s+g}$, that is, the resistance is diminished *by* $\frac{g^2}{s+g}$. If then the shunt be such as to allow $\frac{1}{n}$th of the current to pass through the galvanometer, s, equals $\frac{g}{n-1}$ and the resistance in circuit is diminished by $\frac{n-1}{n} \times g$ when this shunt is applied. For example, if n be 10, the resistance of the circuit will be diminished by $\frac{9}{10}$ths of g.

With our proposed method of keeping a *fixed* resistance, r, attached to the galvanometer, G (fig. 4), and of varying the current through

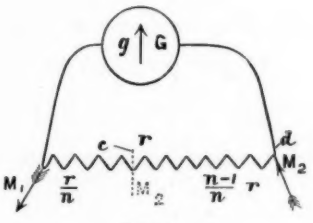


Fig. 4.

the galvanometer by varying the connection of one of the main wires; for example, by moving the main wire, M_2, from the point d to the point c, the resistance of the circuit is altered *from* $\frac{r\,g}{r+g}$ to $\frac{\frac{r}{n}\left(\frac{n-1}{n}\,r+g\right)}{r+g}$, that is, the resistance in the circuit is diminished *by*

$$\frac{1}{r+g}\left\{\frac{n-1}{n}\cdot r\,g-\frac{n-1}{n^2}\,r^2\right\} \qquad (1)$$

Now, this expression depends not merely on the values of n and g, but also on the value of r. If r is selected so as to be less than $n\,g$, the expression (1) is positive, that is, the resistance of the circuit is *lessened* by shifting the main, M_2, from the point d to the point c; whereas, if r is selected so as to be greater than $n\,g$, the expression (1) is negative, which means that shifting the main, M_2, *increases* the resistance of the circuit. Lastly, if r be chosen so as to be exactly equal to $n\,g$, shifting the main produces *no change whatever* in the resistance of the circuit, so that the current *now* passing through the galvanometer after shifting M_2 is exactly $\frac{1}{n}$th of the current that *previously* passed through the galvanometer, for the current in the main circuit undergoes no change whether the resistance of the circuit be large or small.

By selecting r then, so that it is roughly equal to $n\,g$, our proposed arrangement gives the following result on shifting the main, M_2, from d to c:—

(*a*). If the resistance of the rest of the circuit be large compared with that of the galvanometer, the current that *now* passes through the galvanometer is exactly $\frac{1}{n}$th of that which *previously* passed, whatever be the temperature.

(*b*). If the resistance of the rest of the circuit be even small compared with that of the galvanometer, the current that *now* passes through the galvanometer is very nearly $\frac{1}{n}$th of that which *previously* passed, whatever be the temperature.

Contrasted with this we have, with the ordinary method of applying a shunt, the result:—

(*a*). Even if the resistance of the rest of the circuit be large compared with that of the galvanometer, it is only when the temperature has one definite value that the current that *now* passes through the galvanometer is exactly $\frac{1}{n}$th of the current that *previously* passed.

(*b*). If the resistance of the rest of the circuit be small compared with that of the galvanometer, the current that *now* passes through the galvanometer is far greater than $\frac{1}{n}$th of the current that *previously* passed.

Lastly, whatever be the values of g, r, and n, our method of altering the current through the galvanometer produces less change in the resistance of the circuit than the ordinary method. For, as already seen, with the ordinary method of applying a shunt the resistance of the circuit is diminished by $\frac{n-1}{n}\,g$, while, on moving the main, M_2, from d to c with our method, the resistance of the circuit is diminished by

$$\frac{1}{r+g}\left(\frac{n-1}{n}\,r\,g-\frac{n-1}{n^2}\,r^2\right);$$

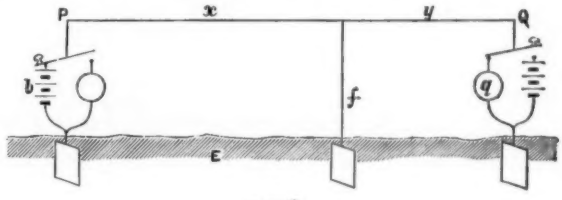
therefore, the ordinary diminution of resistance, minus the diminution of resistance in our case, equals the difference between these expressions, which is

$$\frac{(n-1)\,(n\,g^2+r^2)}{n^2\,(r+g)}. \qquad (2)$$

Now this expression (2) is always positive when n is greater than unity; therefore, our method of shunting produces the *less* change in the resistance of the circuit in all cases.

The Best Resistance for the Receiving Instrument on a Leaky Telegraph Line, by Prof. W. E. Ayrton, F.R.S., past-president, and C. S. Whitehead, M.A. (Read Thursday, March 29th, 1894.)

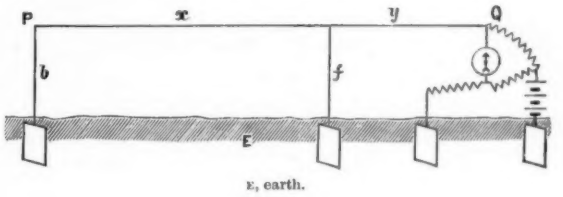
1. If there be a single earth fault at any one point of an otherwise good telegraph line P Q (fig. 1), it is easy to prove that the best



E, earth.

Fig. 1.

resistance to give to the receiving instrument at either end of the line is equal to the apparent resistance of the line tested from *that* end when put to earth at the other end through a resistance equal to that of the signalling battery at that end. For example, if we desire to know what should be the value of q, the resistance of the receiving instrument at the Q end, the line must be tested from the Q end (fig. 2) when put to earth at the P end through a resistance, b, equal to that of the signalling battery usually employed at that end.



E, earth.

Fig. 2.

For if E be the E.M.F. of the signalling battery at the P end, f the resistance of the single earth fault, and x and y the resistances of the two portions of the line, the current, A, that flows through the receiving instrument at Q (fig. 1) equals

$$\frac{f}{f+y+q}\times\frac{E}{b+x+\frac{f\,(y+q)}{f+y+q}}.$$

And the magnetic effect produced by an electro-magnet of given size, shape, and construction is proportional to the product of the current into the square root of the resistance of the wire with which the coil is wound. Therefore, it follows that the magnetic effect of the receiving instrument at Q is proportional to A $\sqrt{q}$, that is, to

$$\frac{f\,E\,\sqrt{q}}{(f+y+q)\,(b+x)+f\,(y+q)};$$

and this has a maximum when

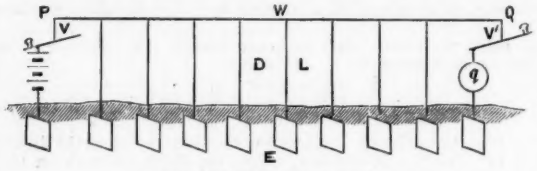
$$q=y+\frac{f\,(x+b)}{f+x+b},$$

that is, when q is equal to the apparent resistance of the line tested from the Q end and put to earth at the P end through a resistance b.

2. During the course of some lectures at the Guilds Central Technical College last year on faults on telegraph lines, the question arose whether the above result was universally true for a distributed

leak all along the line, or only for a single earth fault; and, if this solution were not generally true, then what was the best resistance to give to the receiving instrument at the end of a telegraph line the leakage along which followed any law. The following is the complete solution of this question:—

Let x be the resistance of the line up to any point measured from the sending or signalling end, P, and let $\text{F}(x)$ be the insulation resistance of a length of wire at that point having one ohm conductor resistance. When a signal is sent, let V be the P.D. set up between



D, L, distributed leak; E, earth.

Fig. 3.

the line and the earth at the sending end (fig. 3), and v the potential of the line at any point x: then v is given by the equation,

$$\frac{d^2 v}{d x^2} = \frac{v}{\text{F}(x)}. \qquad (1)$$

If $\text{F}(x)$ be some simple known function of x, it may be possible to integrate this equation, and in that case we may proceed by performing the integration. For example, if $\text{F}(x)$ be a constant, t—that is, if the line be uniformly leaky—then, integrating, and introducing the terminal conditions, it may be shown that

$$v = \text{V}\,\frac{(\sqrt{t}-q)\,\varepsilon^{\frac{x-w}{\sqrt{t}}} - (\sqrt{t}+q)\,\varepsilon^{\frac{w-x}{\sqrt{t}}}}{(\sqrt{t}-q)\,\varepsilon^{-\frac{w}{\sqrt{t}}} - (\sqrt{t}+q)\,\varepsilon^{\frac{w}{\sqrt{t}}}} \qquad (2)$$

where w is the true wire resistance of the whole line, and q is the resistance of the receiving instrument at the far end, Q.

Hence the current passing through this receiving instrument, which is $-\frac{d v}{d x}$ when x equals w, has the value,

$$\frac{2\,\text{V}}{(\sqrt{t}+q)\,\varepsilon^{\frac{w}{\sqrt{t}}} - (\sqrt{t}-q)\,\varepsilon^{-\frac{w}{\sqrt{t}}}};$$

and the magnetic effect, M, is proportional to this expression multiplied into $\sqrt{q}$. From this it may be shown that M is a maximum when

$$q = \sqrt{t}\,\frac{\varepsilon^{\frac{w}{\sqrt{t}}} - \varepsilon^{-\frac{w}{\sqrt{t}}}}{\varepsilon^{\frac{w}{\sqrt{t}}} + \varepsilon^{-\frac{w}{\sqrt{t}}}} \qquad (3)$$

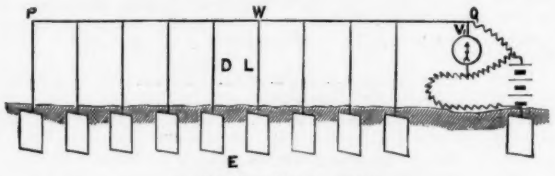
Now, if one end of the line be put direct to earth, we must make q equal to nought in equation (2). Under these circumstances the current $-\frac{d v}{d x}$ at any point x equals

$$\frac{\text{V}}{\sqrt{t}}\,\frac{\varepsilon^{\frac{w-x}{\sqrt{t}}} + \varepsilon^{\frac{x-w}{\sqrt{t}}}}{\varepsilon^{\frac{w}{\sqrt{t}}} - \varepsilon^{-\frac{w}{\sqrt{t}}}} \qquad (4)$$

and therefore the current entering the other end of the line, where the potential is V_1, say, has the value,

$$\frac{\text{V}_1}{\sqrt{t}}\,\frac{\varepsilon^{\frac{w}{\sqrt{t}}} + \varepsilon^{-\frac{w}{\sqrt{t}}}}{\varepsilon^{\frac{w}{\sqrt{t}}} - \varepsilon^{-\frac{w}{\sqrt{t}}}} \qquad (5)$$

If V_1 then be the potential at the point, Q, when the line is tested from the Q end and put direct to earth at the P end (fig. 4), the



D, L, distributed leak; E, earth.

Fig. 4.

apparent resistance of the line will be V_1 divided by the expression (5), and therefore equals

$$\sqrt{t}\,\frac{\varepsilon^{\frac{w}{\sqrt{t}}} - \varepsilon^{-\frac{w}{\sqrt{t}}}}{\varepsilon^{\frac{w}{\sqrt{t}}} + \varepsilon^{-\frac{w}{\sqrt{t}}}};$$

but this is exactly the same as the value found in (3) for q, which made M a maximum. Hence the receiving instrument ought to have a resistance equal to the apparent resistance of the line when tested at the receiving end and put direct to earth at the sending end.

The resistance of the signalling battery does not in this case appear in the best value to give to q, but that arises from the fact that, whereas when we were dealing with a single earth fault we assumed that the signalling battery had a fixed E.M.F. and a fixed resistance, b, here we have assumed that V, the potential of the sending end of the line, was kept constant. Now this is the same thing as supposing that the signalling battery of fixed E.M.F. has an extremely low internal resistance. The two results are therefore the same.

3. Returning now to the general differential equation,

$$\frac{d^2 v}{d x^2} = \frac{v}{\text{F}(x)} \qquad (1)$$

we see that, if the distributed leak may follow any law, $\text{F}(x)$ may be any function of x. The equation therefore cannot be integrated, and we must deal with the problem of determining the best resistance to give to the receiving instrument at the end of the leaky telegraph line without actually integrating equation (1), and without expressing in an explicit form the value of the current that passes through the receiving instruments.

To ascertain the general form of the solution of the above differential equation, whatever function $\text{F}(x)$ may be, let one solution be,

$$v = \phi(x):$$

then

$$\frac{d^2 \phi(x)}{d x^2} = \frac{\phi(x)}{\text{F}(x)}. \qquad (6)$$

Eliminating $\text{F}(x)$ from equations (1) and (6), we have

$$v\,\frac{d^2 \phi(x)}{d x^2} - \phi(x)\,\frac{d^2 v}{d x^2} = 0;$$

$$\therefore \frac{d}{d x}\left\{ v\,\frac{d\,\phi(x)}{d x} - \phi(x)\,\frac{d v}{d x}\right\} = 0.$$

and

$$v\,\frac{d\,\phi(x)}{d x} - \phi(x)\,\frac{d v}{d x} = \text{some constant, say} - b;$$

$$\therefore \frac{d}{d x}\left\{\frac{v}{\phi(x)}\right\} = \frac{b}{\{\phi(x)\}^2},$$

or

$$\frac{v}{\phi(x)} = a + b\int \frac{d x}{\{\phi(x)\}^2};$$

$$\therefore v = a\,\phi(x) + b\,\psi(x) \qquad (7)$$

is the general form of the solution of the original differential equation, the values of the constants a and b depending on the terminal conditions. In fact, as the differential equation No. 6 is linear, it is almost obvious, without any proof, that the general solution of this equation must be of the form given in (7).

In our particular case (fig. 3) the terminal conditions are, when

$$x = 0, \qquad v = \text{V},$$

and when

$$x = w, \qquad v = \text{V}';$$

also, when x equals w the current, A, flowing through the receiving instrument at the Q end of the line, or $-\frac{d v}{d x}$, equals $\frac{\text{V}'}{q}$.

$$\therefore \text{V} = a\,\phi(0) + b\,\psi(0) \qquad (8)$$

and

$$\text{V}' = a\,\phi(w) + b\,\psi(w), \qquad (9)$$

$$\therefore \frac{\text{V}'}{q} = -a\,\phi'(w) - b\,\psi'(w), \qquad (10)$$

if we write $\phi'(w)$ and $\psi'(w)$ for $\frac{d\,\phi(w)}{d x}$ and $\frac{d\,\psi(w)}{d x}$ in the usual way.

Hence, eliminating V' from equations (9) and (10),

$$a\,\{\phi(w) + q\,\phi'(w)\} + b\,\{\psi(w) + q\,\psi'(w)\} = 0. \qquad (11)$$

Eliminating (b) from equations (8) and (11),

$$a\,\{\phi(0)\,\psi(w) + q\,\phi(0)\,\psi'(w) - \psi(0)\,\phi(w) - q\,\psi(0)\,\phi'(w)\} = \text{V}\,\{\psi(w) + q\,\psi'(w)\} \qquad (12)$$

Also eliminating a from the same two equations,

$$b\,\{\psi(0)\,\phi(w) + q\,\psi(0)\,\phi'(w) - \phi(0)\,\psi(w) - q\,\phi(0)\,\psi'(w)\} = \text{V}\,\{\phi(w) + q\,\phi'(w)\} \qquad (13)$$

therefore, substituting in equation (7) the values of a and b given by equations (12) and (13), we have

$$v = \text{V}\,\frac{\{\psi(w) + q\,\psi'(w)\}\,\phi(x) - \{\phi(w) + q\,\phi'(w)\}\,\psi(x)}{\phi(0)\,\psi(w) + q\,\phi(0)\,\psi'(w) - \psi(0)\,\phi(w) - q\,\psi(0)\,\phi'(w)}.$$

Now A, the current flowing through the receiving instrument at the Q end of the line, is $-\frac{d v}{d x}$, where x is made equal to w; therefore

$$\text{A} = \text{V}\,\frac{\psi(w)\,\phi'(w) - \phi(w)\,\psi'(w)}{\phi(0)\,\psi(w) + q\,\phi(0)\,\psi'(w) - \psi(0)\,\phi(w) - q\,\psi(0)\,\phi'(w)},$$

and the magnetic effect is proportional to $\text{A}\sqrt{q}$, and will, therefore, be a maximum when

$$q = \frac{\phi(0)\,\psi(w) - \psi(0)\,\phi(w)}{\phi(0)\,\psi'(w) - \psi(0)\,\phi'(w)}. \qquad (14)$$

Next, let the line be put direct to earth at the P end, and the apparent resistance of the line, with its *non*-uniformly distributed leak, tested from the Q end (fig. 4): then, if x be still reckoned from the P end of the line, the terminal conditions for determining the constants in the general solution,

$$v = a\,\phi(x) + b\,\psi(x) \qquad (7)$$

are, when $x = o, \quad v = 0,$

$$x = w, \quad v = v_1;$$

$$\therefore v = v_1 \frac{\phi(0)\,\psi(x) - \psi(0)\,\phi(x)}{\phi(0)\,\psi(w) - \psi(0)\,\phi(w)};$$

and since the apparent resistance of the line tested from the Q end equals v_1 divided by $\frac{d\,v}{d\,x}$, when x is made equal to w, this apparent resistance will be,

$$\frac{\phi(0)\,\psi(w) - \psi(0)\,\phi(w)}{\phi(0)\,\psi'(w) - \psi(0)\,\phi'(w)};$$

but this is exactly the same as the value of q given in equation (14), that made the magnetic effect a maximum. Hence we may conclude that, whatever be the nature of a leak on a telegraph line—whether the leak be a single one, or be distributed along the line according to any law of distribution—the same rule holds true for the best resistance to give the receiving instrument, viz., *the receiving instrument at either end should have a resistance equal to the apparent resistance of the line when tested from that end and put direct to earth at the other end.*

In what precedes it is assumed that the resistance of a coil of wire occupying a given form and volume is proportional to the square of the number of convolutions. This is absolutely true either when the thickness of the insulating covering is negligible compared with the thickness of the copper, or when the ratio of thickness of the insulating coating to the diameter of the copper is constant for each gauge of wire employed. In a paper on galvanometers,* published in the *Proceedings of the Physical Society*, examples are given of similar coils of silk-covered wire of very different resistances where this proportionality of resistance to the square of the number of windings holds very well. In some other cases, however, as will be seen by referring to that paper, the resistance is more nearly proportional to the number of windings raised to the power five halves.

It is, therefore, worth while considering how the rule given above for the best resistance for the receiving instrument would be varied if the coil of the receiving instrument were wound with such insulated covered wire that M, the magnetic effect, instead of being proportional to A $\sqrt{q}$, were proportional to A q^n. In that case it may be shown that M will be a maximum when

$$q = \frac{n}{1-n} \frac{\phi(0)\,\psi(w) - \psi(0)\,\phi(w)}{\phi(0)\,\psi'(w) - \psi(0)\,\phi'(w)},$$

and this is $\frac{n}{1-n}$ times the apparent resistance of the line when tested from the receiving end and put direct to earth at the signalling end.

Discussion on "Parallel Working through Long Lines," by Mr. W. M. Mordey, March 29th, 1894.

Major-General Webber said it was not generally known that for a considerable time the City company had been running in parallel not only two Mordey-Victoria dynamos, but also one of that make and a Thomson-Houston machine of different size and capacity, supplied and fixed by Messrs. Laing, Wharton & Down, at the station known as the City of London Electric Lighting Company's Pioneer Station at Woolside, which was close upon 2,500 yards away from the Bankside station on the Surrey side of the river, measuring along the cable between the two points. These dynamos differed not only essentially in construction, but also in the motors driving them. The Mordey-Victoria was a 100-kilowatt machine, driven by a Brush vertical inverted engine, the speed of which was about 167 revolutions, and the Laing, Wharton & Down Thomson-Houston high-tension composite field automatic self-regulating alternate current dynamo had a capacity of 120 kilowatts, was driven by Marshall's engines with a speed of about 170 revolutions. These two dynamos, as he had said, were placed in stations 2,500 yards apart by cable measurement, and they were both serving the primary circuits on a transformer station on one bank of transformers. Of course, as they delivered into one area or network of secondaries, it was necessary for those dynamos to be run in perfect parallel, or so far perfect as could be achieved under such circumstances as had been described by Mr. Mordey. The original phase of the two dynamos was different; the Mordey-Victoria was 100 and the Thomson-Houston 130. That difficulty had been overcome, but he was not in possession of accurate information as to how it was done, although they all knew it was not a difficult matter.

Captain Sankey said he would like to have an opportunity of confirming Mr. Mordey as to the ease with which these Mordey alternators could be put into parallel at Thames Ditton. There was not the slightest difficulty, they were direct-connected to two Willans engines, nor was there any sign of their trying to get out of step, although everything was done to get them out of step, with one exception. A brake was put on the fly-wheel of one of the sets until the speed of both sets was reduced to 25 revolutions from a speed of 500. Then they broke away; one set that had not the brake on went up to about 50~, and the other of course remained at 25 until the plank used as a brake was removed. With reference to hunting of the governors, it was quite certain there were governors that did not hunt, and it was also equally certain that those governors must have some amount of friction in them. The fact was, it depended upon where the friction was, and not so much upon the amount. There were other causes. There was a curious injector action which took place sometimes, and synchronism between the time period of the governor, the governor springs being looked upon in the light of a pendulum, and the impulses of the engine, or even the impulses in the steam pipe looked upon as an organ pipe.

Mr. Mitchell read the following communication from Prof. Forbes:—The working of alternators in parallel, or as motors, has hitherto been generally studied as a result of self-induction. The remarkable results which I witnessed in the Mordey machine some years ago led me to examine mathematically the result of there being no self-induction, if this were possible in practice. If the motor have a less E.M.F. than the generator, and they be in the same phase, work is done on the motor at a rate $= \frac{(E - E')\,E'}{2\,R}$ watts, if E, E′ are the E.M.Fs. of generator and motor respectively, and R the resistance of the circuit. If the motor differs in phase, either in advance or retardation from the generator by an angle α, the work done is at a rate $= \frac{E\,E'\cos\alpha - E'^2}{2\,R}$ watts, since this work is a maximum when there is no lag and decreases with the angle of lag. The only stable position is when the motor is in advance of the generator. If, at starting, in approximate synchronism, α has not the value which makes $\frac{E\,E'\cos\alpha - E'^2}{2\,R}$ = the rate of doing work there will be superimposed upon the uniform rotation of the motor, an oscillation about the true value for α until those oscillations are damped out by friction. The period of these oscillations is $\frac{1}{2}\,\pi\sqrt{\frac{M\,R}{E\,E'\sin\alpha}}$ where M is the equivalent mass of the revolving part of the motor at unit radius. Hence if R be small the period is small, and in the Mordey machine it gives a low musical note, which I judged at 16 ~ per second, and which sounded like a deep groan when two alternators were put in parallel with no added resistance and with initial imperfect synchronism. With a larger value of R the period is longer, and, in one case, amounted to two seconds to four seconds for the complete period, as judged by me from the pulsations of the Sunbeam lamps in our Thames Ditton experiment.

(To be continued.)

* "Galvanometers," by Prof. Ayrton, T. Mather, and W. E. Sumpner, D.Sc., *Phil. Mag.*, July, 1890, page 86.

NEW PATENTS—1894.

5,690. "Improvements in connection with microphones." H. Oppenheimer. Dated March 19th.

5,693. "Improvements in gas engines." J. Allan. Dated March 19th.

5,721. "New or improved process and apparatus for the electrolytic decomposition of common salt." C. Smith. (Communicated by G. Jorgensen, Norway.) Dated March 19th.

5,728. "Adapting electromotors to dental purposes." W. Routledge. Dated March 20th.

5,735. "Improvements in electrical switchboards." E. J. Paterson and C. W. Hill. Dated March 20th.

5,754. "An improvement in electrical arc lamps." W. H. Lauder. Dated March 20th.

5,796. "Improvements in underground conduit systems for electric railways." H. A. F. Petersen. Dated March 20th. (*Complete.*)

5,806. "An improvement in dynamo-electric machines and apparatus for driving them." A. S. Baxendale. Dated March 20th.

5,807. "A duplex electrical safety fuse." The Edison and Swan United Electric Light Company, Limited, and C. F. Proctor. Dated March 20th. (*Complete.*)

5,816. "Improvements in electrical measuring instruments." H. H. Lake. (Communicated by E. Weston, United States.) Dated March 20th. (*Complete.*)

5,827. "An improvement in turbines or water-wheels." R. Pearson. Dated March 20th.

5,843. "Improvements in gas and oil engines." J. P. Binns and H. G. Binns. Dated March 21st.

5,863. "Improvements in fuse boxes for electricity supply mains." H. Reason. Dated March 21st.

5,913. "Improvements in alternators." J. S. Raworth. Dated March 21st.

5,916. "Improvement in or connected with gas and oil engines." W. von Pittler. Dated March 21st.

5,917. "Improvements in and relating to telephone and telegraph systems." Sir C. S. Forbes, Bart. Dated March 21st.

5,918. "Improvements in arc lamps." S. S. Allin and W. H. Wood. Dated March 21st.

5,921. "An improved telephone combination." Sir C. S. Forbes, Bart., and The Domestic Telephone Company, Limited. Dated March 21st.

5,922. "An improved automatic electric machine." A. Howard. Dated March 21st.

5,931. "Improvements in electrically propelled common road vehicles." E. J. Clubbe and A. W. Southey. Dated March 21st.

5,932. "An improvement in electrically-propelled vehicles." E. J. Clubbe and A. W. Southey. Dated March 21st.

5,971. "Improvements in apparatus for the use of the electric light for photographic purposes." A. G. Adamson. Dated March 22nd. (*Complete.*)

6,003. "Improvements in oil and gas engines." E. Lange. Dated March 22nd.

6,028. "An improvement or improvements in electro-dynamo machines and in electromotors." S. Jevons. Dated March 22nd.

6,046. "Improvements in the methods of effecting the electrolysis of saline solutions." L. A. P. Lienard and H. E. A. Lienard. (Date applied for under Patents, &c., Act, 1883, Sec. 103, September 22nd, 1893, being date of application in France.) Dated March 22nd. (*Complete.*)

6,057. "Improvements in electrical conductors and in the method of making connections between electrical conductors." H. Edmunds. Dated March 22nd.

6,059. "Improvements in means of and apparatus for neutralising the vibrations of moving machinery." A. P. Trotter. Dated March 22nd.

6,089. "Improvements in the means of protecting electrical conductors." J. A. Kingdon. Dated March 24th.

6,096. "Improvements in gas and oil motor engines." W. Le P. Webb. Dated March 24th.

6,138. "Improvements in oil and gas engines." H. T. Reid. (Communicated by G. B. Brayton, United States.) Dated March 24th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

516. "Improvements in measuring and recording instruments for electric currents." H. H. Lake. (Communicated from abroad by E. Weston, of America.) Dated January 10th. Consists in an electrical measuring instrument which may be arranged as either a voltmeter for measuring electrical pressure, or an ammeter for measuring current strength. The construction is such that the variations in electromotive force or pressure are registered upon a moving record surface. 2 claims.

4,360. "Improvements in the construction of plates for accumulators or secondary batteries." W. P. Thompson. (A communication by La Société Electric Phœbus, of Paris.) Dated February 28th. In this invention the plates are cast in two grated faces held apart and rendered solid by cross-pieces which are also cast at the same time with the said plates. 2 claims.

6,935. "Improvements in meters or apparatus for making measurement of electrical energy." A. G. Brookes. (Communicated from abroad by H. C. Wirt, of Boston, America.) Dated April 4th. Relates chiefly to an electric meter containing an armature consisting of a hollow closed conductor of copper or other non-magnetic conducting material, of series coils through which passes the current to be measured, and shunt coils arranged with their common axis at right angles to the common axis of the series coils and connected as a shunt across the circuit leading to the translating devices, said parts constituting an electric motor which develops a torque proportional to the energy passing through the motor. 10 claims.

8,952. "Improvements in electric accumulators." F. W. Ellermann. Dated May 4th. Consists in applying an active porous mass in a comparatively thick layer; electrically connecting the individual particles of such mass by means of mercury so as to reduce the resistance; and, for the purpose of avoiding too rapid a discharge, adding to the mass a finely divided electrolytically inert body. 4 claims.

10,533. "Improvements in electrical signalling and printing telegraph systems, and in apparatus employed therein." J. Y. Johnson. (Communicated from abroad by A. S. McCaskey, of Chicago.) Dated May 30th. Primarily the object of the invention is to produce, with the minimum number of working parts, the maximum number of electrical signals, represented by combinations of electric impulses, in which each individual signal differs from all the others, in the number of operating impulses which compose it, or in the intervals separating these impulses. 15 claims.

10,843. "Improvements in or connected with electric railways and tramways." J. Claret and O. Wiulleumier. Dated June 2nd. Relates to electric railways and tramways, in which automatic distributors are employed to supply the current to the motors. 7 claims.

12,662. "Improvements in electrolysis." E. Andreoli. Dated June 28th. The object of this invention is an improved electrolytic apparatus, in which a chloride of sodium or other solution is decomposed into its constituent parts, while circulating through positive and negative compartments formed by partitions made of asbestos or kieselguhr or other similar porous porcelain, closely situated between metallic or carbon cathodes and retort carbon anodes, constructed in a very simple, economical, and efficient manner. 7 claims.

13,081. "Improvements in the construction of plates for secondary batteries." J. Pitkin. Dated July 4th. According to the present invention, the building of troughs into a battery plate is facilitated by making the troughs with solid ends, provided underneath with steps, which act the part of spacing pieces for the troughs. 2 claims.

14,315. "Improvements in galvanic elements." C. W. A. Hertel. Dated July 25th. Relates to a combination of zinc, copper, and carbon, and a depolarising substance. 4 claims.

14,485. "Improvements in multiple point switches suitable for use in electric lighting." F. H. Nalder, H. Nalder, C. W. S. Crawley, and A. Soames. Dated July 27th. The inventors mount two switch levers on the same axis so that they move in parallel planks at only a short distance apart, but sufficiently far to admit the contact blocks between them. The contact blocks radiate from the centre, or axis, and the contacts are made by the two switch levers on the opposite sides of the blocks. The improved construction admits of all the contact blocks being of the same pattern, which reduces the cost of construction. 3 claims.

14,516. "Improvements in and connected with electric furnaces." A. F. W. Kreinsen. Dated July 28th. The object of this invention, which relates to electric furnaces, is to enable metals to be melted with great certainty and so as to obtain a cleaner product with the castings or ingots free from flaws and blow holes. 4 claims.

15,257. "Improvements in and connected with galvanic batteries." S. Marcus. Dated August 10th. Relates to a helical propeller like or screw electrode, which stirs up the solution. 6 claims.

15,343. "Improvements in and relating to the attachment of electric lamps to their posts." W. Osenberg. Dated August 11th. Consists in mounting the lamp on or between swinging angle levers mounted on a pulley adapted to run in guides up and down the said post, the said angle levers being swung over by stops arranged at the upper part of the post when the lamp has been hoisted into its highest position, whilst on lowering the lamp the said levers are swung back by means of other stops, thus bringing the lamp back into a position sideward of the post.

15,681. "Improvements in electric accumulators or storage batteries." G. H. Roe and G. Sutro. Dated August 18th. The improvements consist in a series of corrugated and perforated grid plates made of wood, preferably sequoia, or other porous and flexible varieties, permeable by the liquid solution in which the battery is immersed, such plates or forms being alternated with and confined by lead plates or electrodes, the whole being compressed by elastic bands or other suitable means to form a structure self-contained and capable of being placed in or removed from a receiver without disturbance of the active materials sustained by the separating and flexible containing plates. 4 claims.

15,906. "Improvements in and relating to electrolytic apparatus." D. Young. (Communicated from abroad by La Société Outhenin Chalandre Fils et Cie, of Paris.) Dated August 22nd. Relates to an improved electrolytic apparatus chiefly designed for the electrolysis of sea salt or chloride of sodium with a view to the simultaneous production of caustic soda in solution and of chloride of lime in the form of powder or liquid, and in the latter case free from sea salt. 6 claims.

15,957. "Improvements connected with assistant or auxiliary electromotors." La Societe Anonyme Pour la Transmission de la Force par l'Electricite, of Paris. (Under International Convention.) Dated March 15th. Relates to a differential movement of two bevel wheels gearing in an inverse direction with a series of movable pinions, so that, if there is imparted to the two wheels an equal speed in opposite directions, the pinions remain stationary; but when the speed becomes unequal, the pinions will travel round a common axis at a speed equal to half the difference in the speed of the wheels. 3 claims.

15,963. "Improvements in electric indicators." B. Zeitschel. Dated August 23rd. Claim:—An indicator movement in which the lever arm carrying the indicator disc is held in the position of rest by a movable core in a solenoid-spool whilst it is left free when a current passes and raises this core and the indicator disc falls, substantially as described.

16,027. "Improvements in connections for local supply from electrical mains." Siemens Brothers & Co., Ltd., and H. G. Knorr. Dated August 24th. Claim:—A connection for local supply of electricity, consisting of a partitioned and covered insulating base having fixed on it clamps for bared portions of a pair of electrical mains, each clamp connected by a safety fuse wire to a holder for the bared end of one of a pair of local leads, substantially as described.

16,562. "Improvements in electric motors." B. Willcox. (Communicated from abroad by E. R. Esmond, of New York.) Dated September 2nd. Relates to electric motors in which both the field and the armature are rotatable, and are combined with an intermediate pinion or the like, by which they are geared together, and consists in making this intermediate pinion, or the like, capable of bodily swinging movement, to which end it is mounted on a carrier which is pivoted to allow the necessary swinging movement of the intermediary. 5 claims.

17,127 "Improvements in electrolytic cells." T. Craney. Dated September 12th. Relates more specifically to the construction of electrolytic cell for the commercial electrolysis of chlorides, such as chloride of sodium, for making chlorine and caustic soda. 1 claim.

17,646. "Improvements in telephone switch operating mechanism." T. W. Ness. Dated September 19th. Relates to the switch mechanism of warehouse or local telephone systems, in which each department or office has a segmental keyboard, with an independent axially mounted spring key or switch bar, adapted to be shifted by hand from a normal resting point or line terminal segment to any of the other line terminal segments or points of the keyboard to secure the necessary line connection with other departments or offices of the system, the object of the invention being to provide an automatic return for such key or switch after the user has finished talking, so as to avoid all chances of the key not being returned, as is required by the nature of such systems. 7 claims.